Mechanical World
AND ENGINEERING RECORD
Monthly : Two Shillings and Sixpence JANUARY, 1960

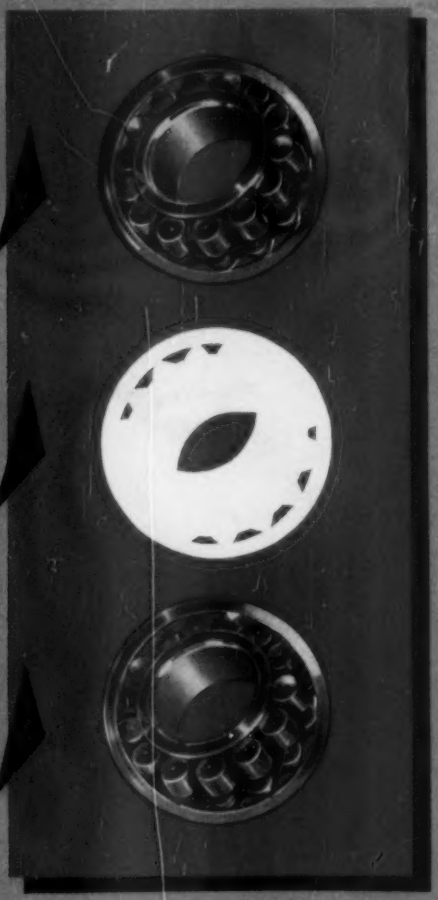
There is no substitute for

the right bearing .....

in the right place .....

..... *except, of course,*

another SKF bearing !..



THE SKEFKO BALL BEARING COMPANY LIMITED, LUTON, BEDS.
THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER & SPHERICAL ROLLER

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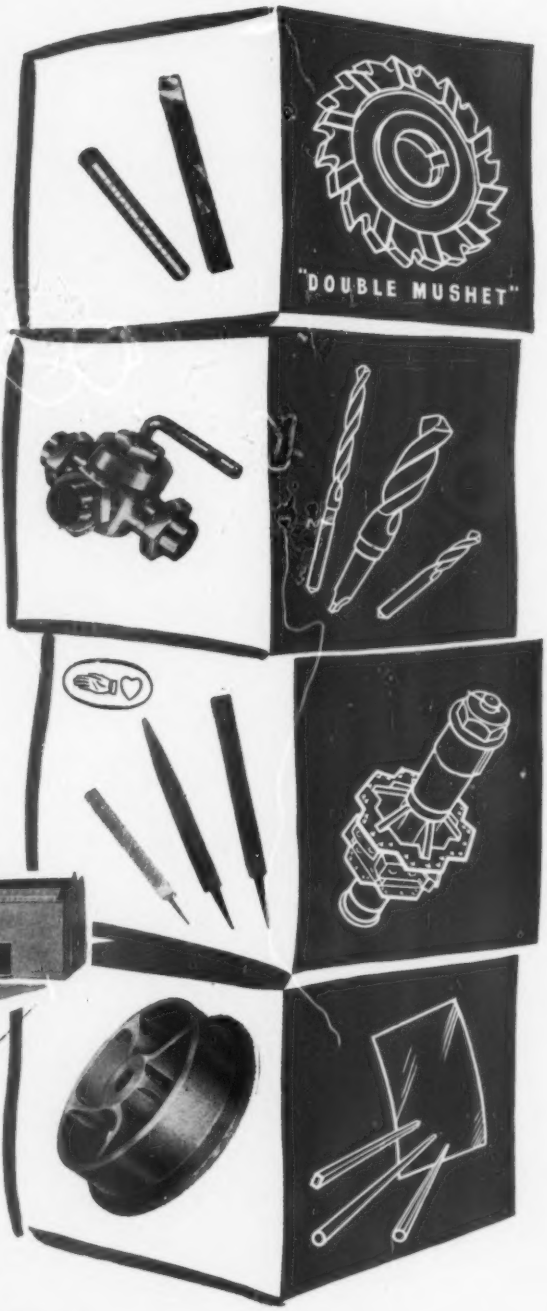
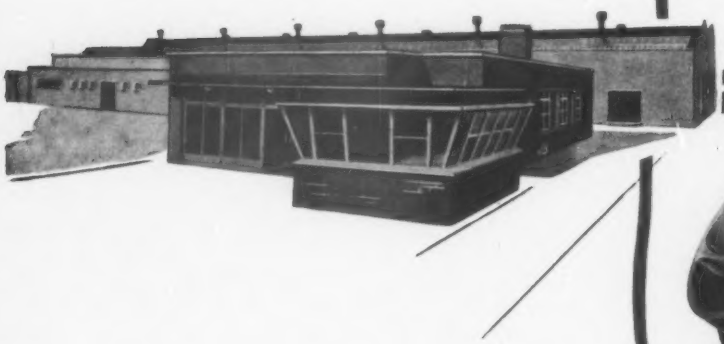
OSBORN PRODUCTS

Integrated experience from over a century of craftsmanship has made the name of *Osborn* world-famous as a hallmark of quality in the manufacture of fine steels and steel products.

Products in alloy, stainless and tool steels are manufactured throughout within the same organisation, and include castings by general foundry and precision methods, forgings and engineers' cutting tools.

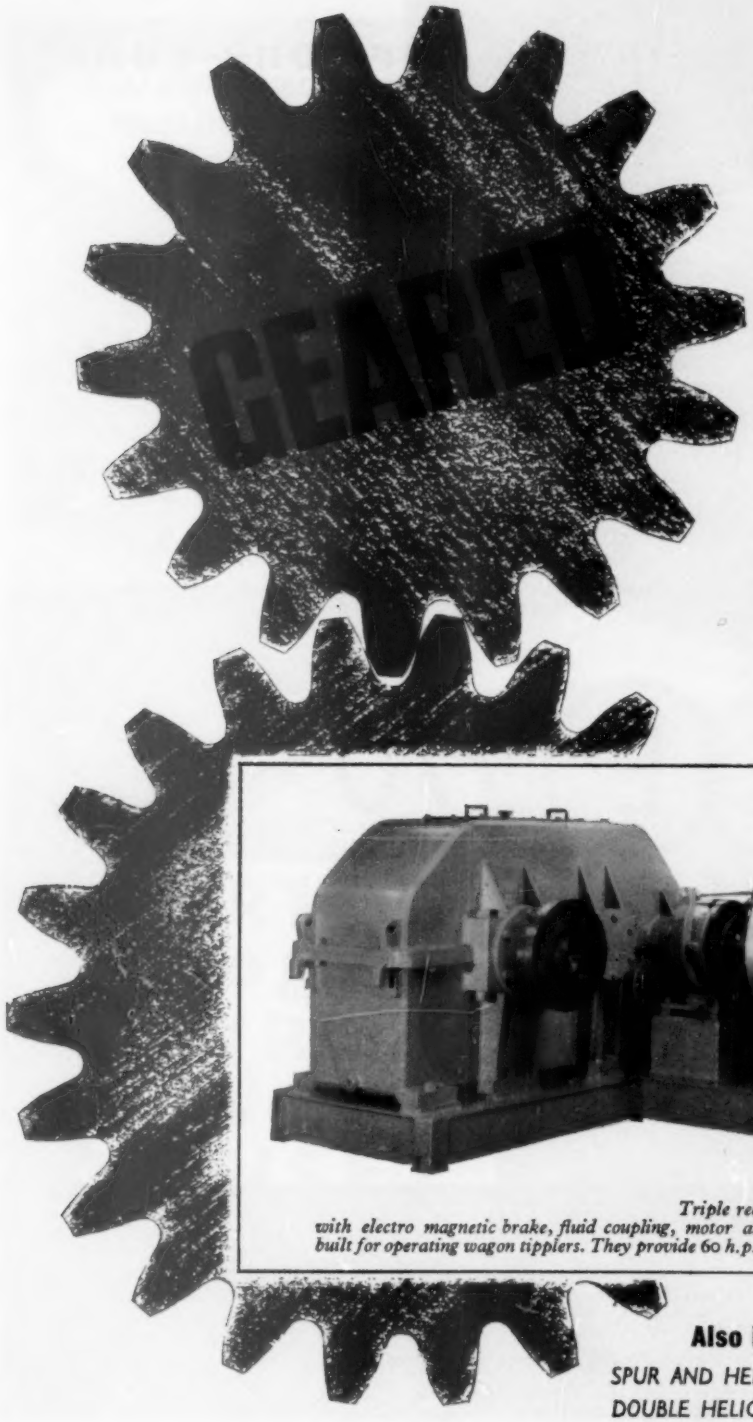




STEELMAKERS · STEELFOUNDERS · ENGINEERS' TOOLMAKERS

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD

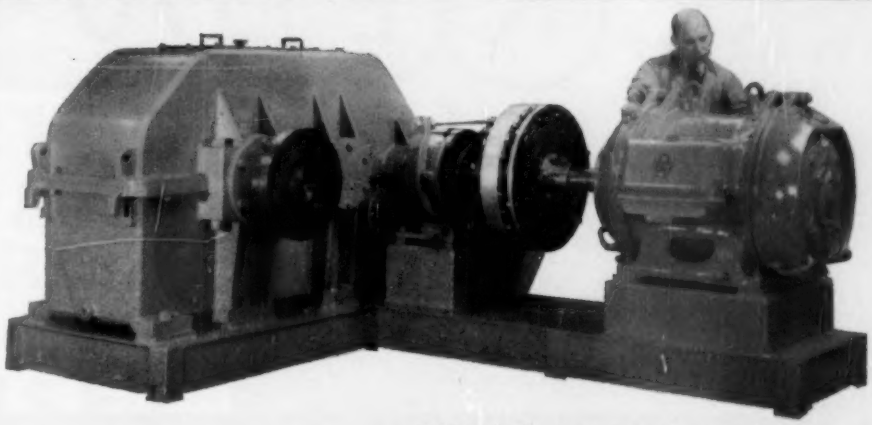


for the design and production of SPECIAL GEAR UNITS

Superb facilities are available at Angus Gear Division for the design and manufacture of gear units of all kinds to meet every industrial need.

An unusually complete service in this field, outstanding in its scope and quality, is the result of an accumulation of experience and valuable technical skill, allied to one of the most advanced gear cutting plants in Europe.

We shall be pleased to discuss your gear requirements



Triple reduction double helical gear unit, complete with electro magnetic brake, fluid coupling, motor and base plate — one of several such units built for operating wagon tipplers. They provide 60 h.p. at 750 r.p.m. and are splash lubricated.

Also in regular production are:

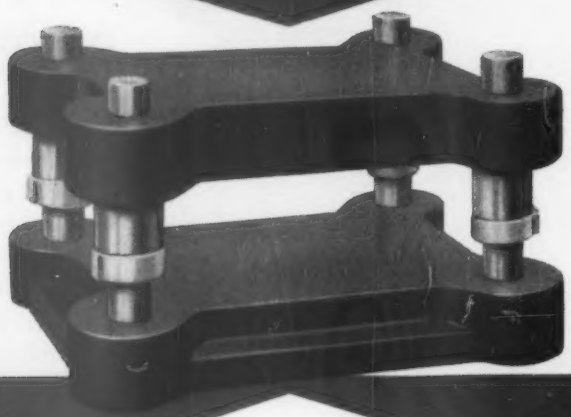
SPUR AND HELICAL GEARS up to 78" diameter.
DOUBLE HELICAL GEARS up to 5 ft. diameter.
WORM GEARS up to 24" centres.
BEVEL GEARS up to 5 ft. diameter.
PROFILE GROUND SPUR, HELICAL AND WORM GEARS.
DURANGUS AND PEAK NON-METALLIC SILENT GEARS.
RAWHIDE SILENT PINIONS.
GAMAX GEARED MOTOR UNITS.
AUTORAM ELECTRO-MECHANICAL THRUST UNITS.

GEORGE ANGUS & Co LTD

GEAR DIVISION

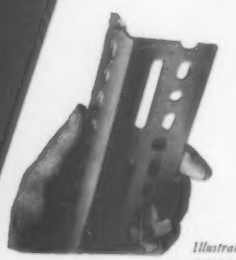
PRINCE CONSORT ROAD, HEBBURN-ON-TYNE

Are YOU tooling-up for long runs?



KE 970

2% CARBON 14% CHROME HIGH DUTY TOOL STEEL



WAS CHOSEN BY MESSRS DEXION LIMITED

for the dies and punches to produce their famous slotted angle. Millions of slots have been punched with the minimum amount of tool regrinds.

Illustration by courtesy of MESSRS. DEXION LIMITED.

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Established 1825

Stocks held at:- Carlisle Steel Works, SHEFFIELD 4. Tel.: Sheffield 22124.
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WALKER'S 'LION' CHEVRON & TWINSET

Packings on 4,500 ton press

Walker's packings are used throughout a 4,500 ton hydraulic plate press at Whessoe Ltd., Darlington. Possibly the largest of its type in the world, it was designed specially for the shaping of spherical pressure vessels for atomic power stations. The pressure vessels (made from well over 1,000 tons of steel) have walls up to 4 inches thick which are pressed from plates weighing up to 10 tons.

The illustration above shows this giant plate press built by Messrs. Fielding & Platt.

Free technical literature on Walker's 'Lion' Chevron and Twinset packings, which are giving such outstanding service on all types of presses throughout the world, will be sent on request.

TIB.340

James WALKER & CO. LTD.

'LION' WORKS, WOKING, SURREY, ENGLAND

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DEPOTS THROUGHOUT THE WORLD

Tecalemit mechanical lubrication safeguards machinery and saves money

With Tecalemit Mechanical Grease Lubrication, every bearing gets exactly the right amount of grease at correct intervals. Machinery works better and lasts longer. Neglect and human error are eliminated.

There's a threefold saving—in power costs, in lubricant costs, and in labour costs. And there's a positive improvement in works safety when Tecalemit Mechanical Lubrication replaces frequent hand greasing.

The two main Tecalemit Mechanical Grease Lubrication systems are suitable for every type of installation. They can be incorporated into a new design or fitted to existing machines with equal success.

The SINGLE-LINE system uses a central pump, which can be fully automatic, operator-controlled, or hand operated, and a single main distributor line. Each bearing is fed by a separate Tecalemit Single-Line Injector, in effect an automatic metered grease nipple.

The RADIAL system incorporates 19 separate miniature pumps, each serving a bearing. Each pump's output is regulated according to need. The system can be driven from the machine it serves, or supplied complete with electric motor. Fully automatic, the RADIAL system is ideal for heavy machinery working at high pressure.

(There are also Tecalemit Mechanical Lubrication systems for use with every grade of lubricating oil.)

Tecalemit, the Authority on Lubrication, can solve *your* lubrication problem. Fill in this coupon and post it today. If you have a particular application or trouble-spot in mind, by all means enclose a note, a sketch or a drawing. You will be under no obligation whatsoever.

To TECALEMIT LTD (Sales MEW)
PLYMOUTH, DEVON

Please send me full information on:—

Tecalemit SINGLE-LINE Grease Injection systems ☐

Tecalemit RADIAL Grease Pump systems ☐

All Tecalemit Mechanical Lubrication systems for grease and oil ☐

I enclose details of a particular lubrication problem ☐

NAME .....

COMPANY .....

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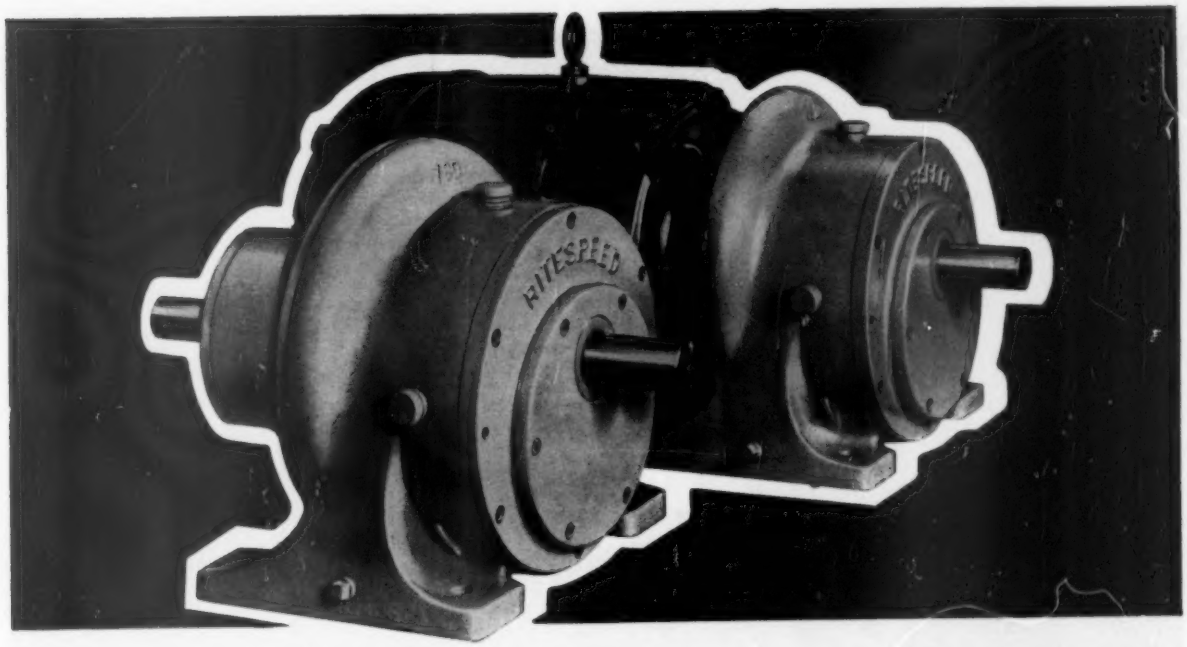
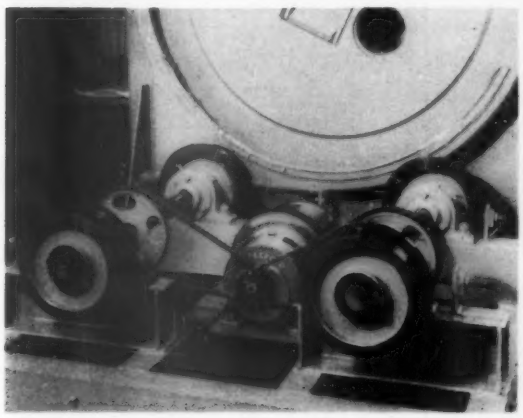


VERSATILITY+RELIABILITY= 'RITESPEED'



A Tumbling Barrel driven through a "Ritespeed" Geared Motor equipped with chain drive.

"Ritespeed" is the name given to the well-known range of Spur Reduction Gears and Geared Motors produced by Crofts of Bradford.

Compact in design, they can be mounted in any position, and there is a Flange-Mounted Series, including Vertical Geared Motors for use with stirrers, mixers, and similar machines.

Gear cases are made from Crofts semi-steel, a tough, durable, close-grained metal, and the gears are accurately machined from high-tensile steel bars or forgings dependent on the size of the unit.

The Geared Motors and Reduction Gears cover the same power range, the former taking any make or type of flange-mounting electric motor.

In addition, the incorporation of a HIRATIO adaptor enables ratios up to 2175:1 to be obtained, while the inclusion of a MULTISPEED unit provides two, three, or four speed changes, selected by hand lever.

"Ritespeed" Geared Motors and Reduction Gears can be supplied from fractional up to 80 H.P. Ratios up to 82 : 1.

Up to 20 H.P. supplied FROM STOCK.

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POWER TRANSMISSION ENGINEERS

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REPRESENTATION THROUGHOUT THE WORLD

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☐ "RITESPEED" GEARED MOTORS & REDUCTION GEARS. *Publication 5737A*

Literature also available on:

☐ SHAFT-MOUNTED GEAR UNITS. *Publication 157A*

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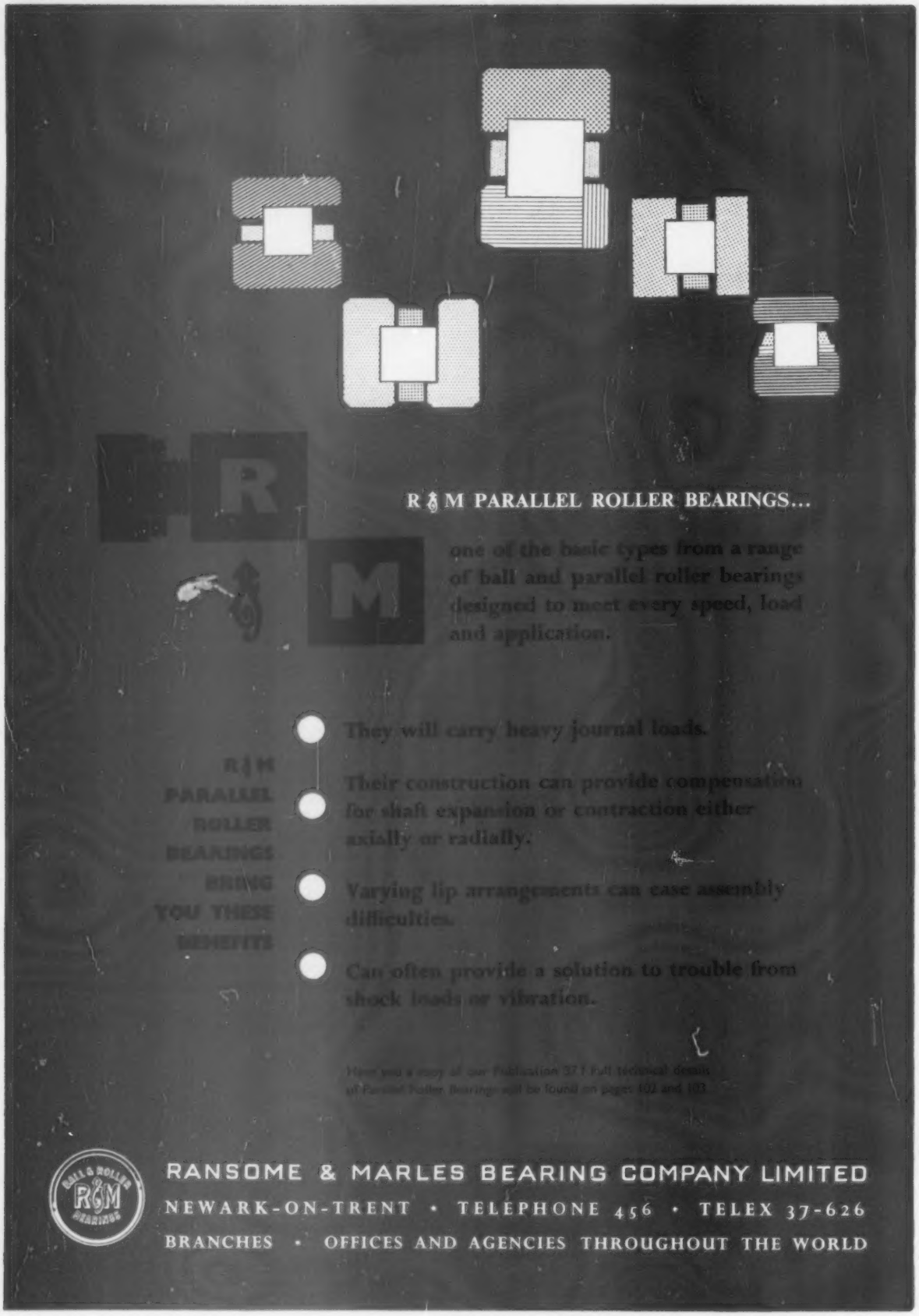
☐ 4", 6" & 8" WORM GEARS To EEUA Standard Dimensions. *Publication 5743*

Name .....

Address .....

Please indicate which items are required. MW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one of the basic types from a range of ball and parallel roller bearings designed to meet every speed, load and application.
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They will carry heavy journal loads.
Their construction can provide compensation for shaft expansion or contraction either axially or radially.
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Can often provide a solution to trouble from shock loads or vibration.
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BRANCHES • OFFICES AND AGENCIES THROUGHOUT THE WORLD

For a wonderfully smooth drive...

Holroyd worm gears

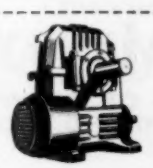
Three things are needed for making a good worm gear. First, a wheel material to give hard wear and low friction—in our case this means Holfos centrifugally cast bronze. Second, high precision machine tools, cutters and testing appliances—we have been making our own for years. Third, a thorough knowledge of worm gear design and application, coupled with an inexhaustible supply of patience—well we've been in the worm gear business for nearly a century and during that time we've overcome some pretty tough problems. That's why we say: there is (or very soon can be) a Holroyd worm gear for almost every application.

Did you know that all Holroyd worm gears are made using a unique technique which gives some allowance for the inevitable deflection of bearings and gear housing? This gives improved performance with the gears working correctly in the **loaded** position.

In certain cases we go further than this and make the gears so that they have some latitude in assembly without impairing the efficiency.

Another point—our worm gears are made, if required, right down to 1/1 ratio as an everyday product. And don't forget that these Holroyd gears will carry several times the load of straight faced spiral gears of the same dimensions, and will work with an efficiency of the order of 97 per cent.

Have a word with **Holroyd**



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FRICTION DROP HAMMERS

for economy in Drop Forging

Low running and upkeep costs make Massey Friction Drop Hammers particularly suitable for the production of a wide range of accurate drop forgings. They are easily controlled thus ensuring minimum operator fatigue, and are made in various types, Automatic, Hand-Controlled, Self Contained Form or Bridge Type as illustrated. The Bridge Type hammers are made in a variety of sizes from 10 cwt. up to 16 ton.

STAND 26, GRAND HALL, INTERNATIONAL MACHINE TOOL EXHIBITION, OLYMPIA, JUNE 25th—JULY 8th, 1960

2 Ton Bridge Type Friction Drop Hammer, Messrs. Kirkstall Forge Engineering Ltd., Leeds.

MASSEY DESIGNS INCLUDE :-

Steam and Compressed Air Hammers, Pneumatic Power Hammers, Friction Drop Hammers, Double-Acting Steam and Compressed Air Drop Hammers, Counterblow Hammers, Forging Presses, Use Rollers, Trimming Presses, Tyre Fixing Rolls.

B&S. MASSEY LTD. OPENSHAW · MANCHESTER · ENGLAND

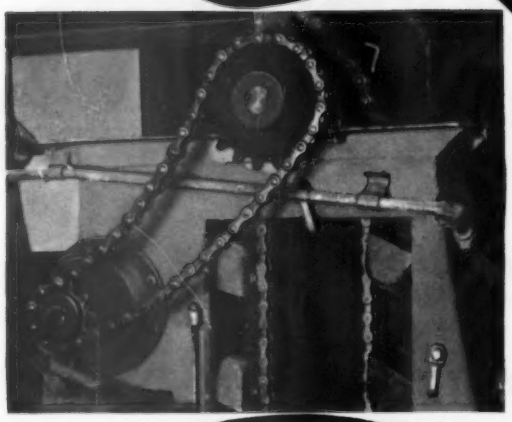
MAKERS OF THE WORLD'S GREATEST RANGE OF FORGING AND DROP FORGING PLANT.

YOU'VE GOT TO HAND IT TO

for better service and better performance

THE COVENTRY MARK 5

STEEL ROLLER CHAINS



The Coventry Mark 5 chains, especially designed for slow-speed driving and light conveying in rough and exposed conditions, are rapidly replacing malleable and pressed steel chains. Manufacturers are realising that, although the initial cost of a chain with rollers is naturally higher, the goodwill created by the greatly improved performance and very much longer life of The Coventry Mark 5 chains outweighs other considerations.

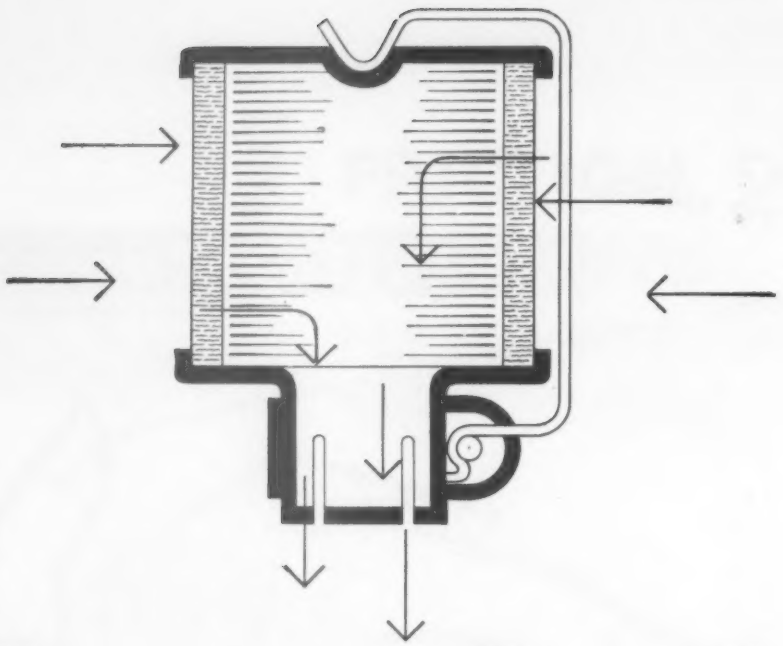
This bucket elevator is used in the production of tinned plate and is fitted with The Coventry Mark 5 chains which at the time the photograph was taken had given twelve months trouble-free service without signs of wear. They replaced the original malleable chains which had a life of only one month.

THE COVENTRY MARK 5

Steel roller chains replace malleable chains and run on the same wheels

RENOLD

RENOLD CHAINS LIMITED • MANCHESTER



The *new* Tecalemit

RIBBON FILTER ELEMENTS

set a fresh standard of high efficiency filtration

for Air–Water–Petrol, diesel and fuel oils–Lubricating, hydraulic and other fluids

Tecalemit Limited (Sales MEW), Plymouth, Devon

Tecalemit Ribbon Filter Elements

Simple construction–Low cost–High flow rate–Easy to clean

The elements are formed of resin impregnated cellulose ribbon, wound helically and electrically polymerised and fused to form an open-ended cylinder. The standard range of diameters (in any length) covers most applications, and no other filtration material can so readily be adapted to individual requirements for filters, strainers or breathers.
Never before has such fine filtration been possible at such low cost and with such flexibility in use.

Innumerable microscopic orifices between the helically wound ribbons of the elements allow a very high flow rate, while retaining impurities on the outside or inside surfaces, according to direction of flow. Reverse flow readily cleans the elements, or they may be washed in petrol or paraffin.
Uses for Tecalemit Ribbon Filter Elements include:
carburettor inlet filters for small engines;
air intake filters for compressors and exhausters;
water separators for fuel and air lines;
filters and strainers for petrol, diesel, fuel and hydraulic oils, and oil burners, etc;
engine crankcase breathers and breathers for hydraulic tanks and systems.

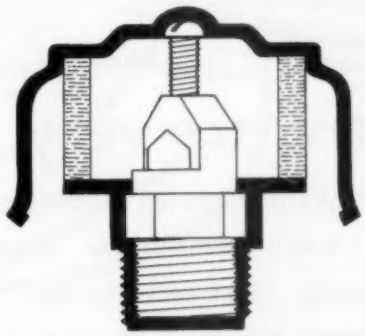
Tecalemit Ribbon Elements filter to maximum purity

Tecalemit Air Breather Filters

(incorporating Tecalemit Ribbon Filter Elements)

Cheapest—Most efficient—Cleanest to service

Of the standard types, two are breathers with screwed bodies, available in a range of British and American threads, and the third is a combined clip-on assembly of breather and filler cap, replacing the standard "pan-scrubber" type filter.



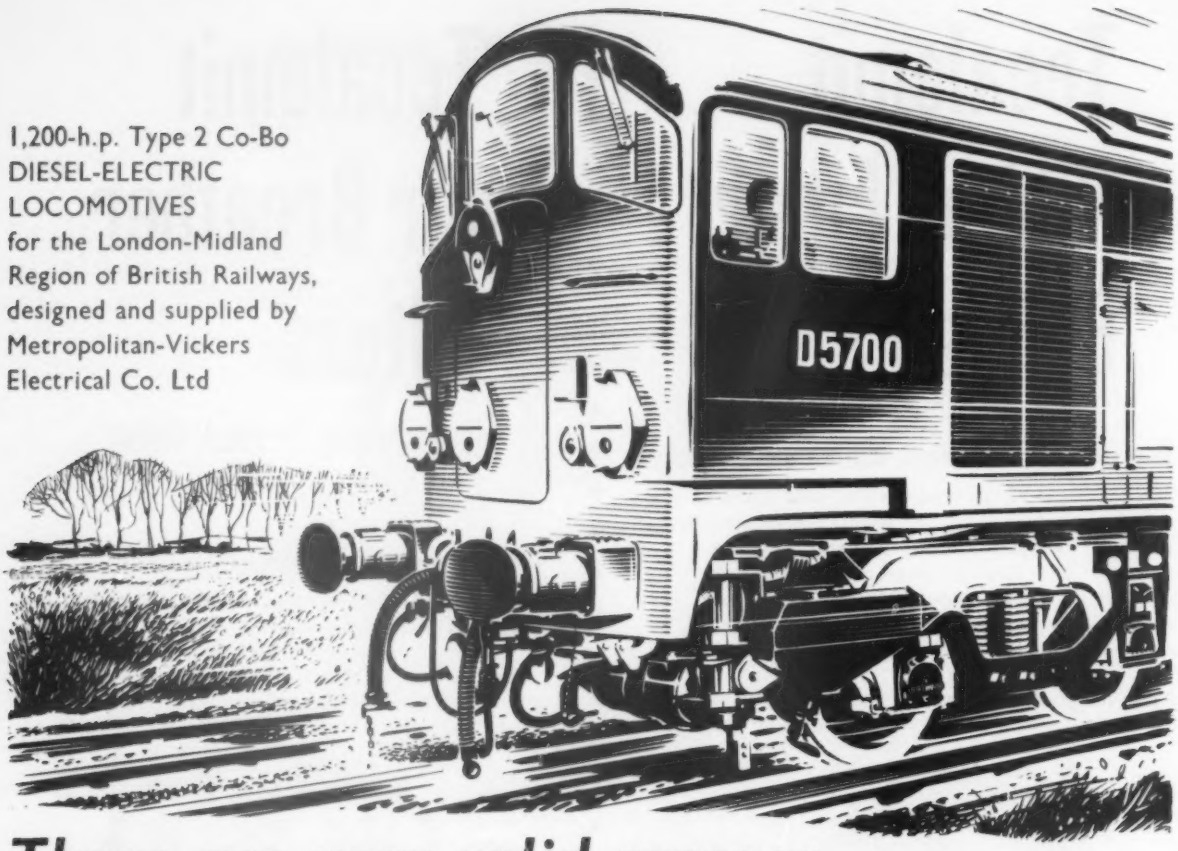
All are fitted with Tecalemit Ribbon Filter Elements, and are suitable for engine crankcases; air and vacuum brakes; hydraulic oil tanks and rams; gearboxes, pneumatic cylinders and servo mechanisms, etc.
Tecalemit Breathers fitted with ribbon elements act as ventilators to provide a free flow of clean air to hydraulic fluid, fuel and oil reservoirs. They compensate for changes in liquid level, temperature or altitude, as well as giving positive protection from airborne contamination to tanks, pumps, valves, cylinders and other components.

Tecalemit Breathers give pure air cheaply and efficiently

TECALEMIT–*the authority on filtration*

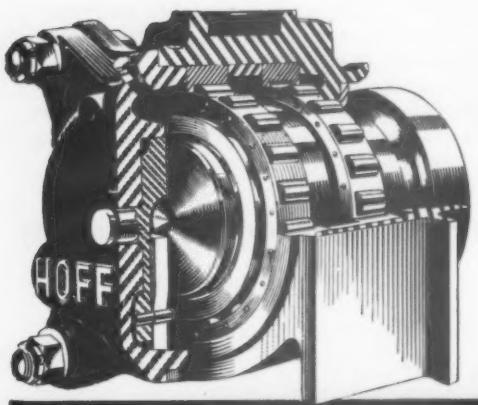
T698

1,200-h.p. Type 2 Co-Bo
DIESEL-ELECTRIC
LOCOMOTIVES
for the London-Midland
Region of British Railways,
designed and supplied by
Metropolitan-Vickers
Electrical Co. Ltd



There are very solid reasons . . .

why the name of Hoffmann is deep-rooted in the minds of railway engineers. What was claimed for these axleboxes 30 years ago is now everyday experience. Just to reiterate: Hoffmann boxes are almost wearless; eliminate hot boxes; substantially reduce lubrication and maintenance costs; eliminate all wear on axles. Their easy starting results in less wear and tear on drawing gear and with locomotives, absence of wheel slip with uneven tyre wear.



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ROLLER BEARING
AXLEBOXES

for solid satisfaction

HOFFMANN

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

So simple!

So surely SIMPLIFIX the foolproof coupling!

Simplifix couplings form a perfect joint on almost any kind of tubing including those with very thin walls. All that is required is tightening with a spanner – no special work is required on the tube and the anti-friction washer prevents the tube twisting when the nut is tightened. Simplifix couplings are suitable for all pipe line systems up to 2″ o.d. In a wide range of interchangeable standard fittings. Non-standard fittings of all kinds can also be made to order. Write for further information and fully illustrated catalogue.

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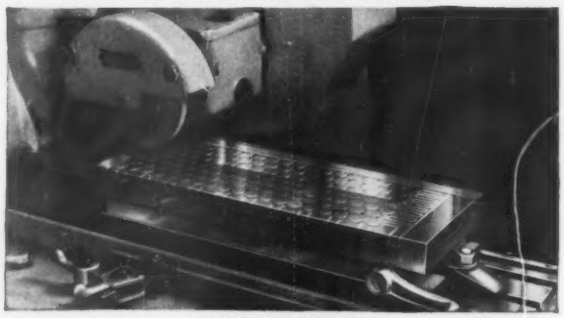
offers the most complete magnetic work holding service

RECTANGULAR CHUCK

HEAVY DUTY CIRCULAR CHUCK



FINE POLE CHUCK

MINOR CHUCK

MAGNETIC VEE BLOCK

SMALL TOOLMAKERS CHUCK
MOUNTED ON SWIVELLING BRACKET

Ask for detailed literature

Made by James Neill & Co. (Sheffield) Ltd. and available through your usual 'Eclipse' dealer

PM 156

Churchill

MODEL HBM
AUTOMATIC SIZING INTERNAL GRINDING MACHINE

Finishing Jet Engine Bearings

at

FISCHER BEARINGS CO LTD
WOLVERHAMPTON

BRITISH MACHINE TOOL MAKERS ASSOC. LTD

CHURCHILL automatic sizing internal grinding machines are renowned for their accuracy and speed of production, and our illustration shows one of a battery of Model H B M grinders engaged on jet engine bearings at Fiscner Bearings Co. Ltd., Wolverhampton.

OUTSTANDING FEATURES INCLUDE:—

- Single or double automatic operation cycle.
- Plunge cut or traverse grinding.
- Feed accelerator reduces production time.
- Diminishing feed rate to zero with variable dwell.
- Adjustable oscillation.

Full details of these and other outstanding advantages sent on request.

Precision plus Production

THE CHURCHILL MACHINE TOOL CO. LTD.,

BROADHEATH, NR. MANCHESTER Phone Altrincham 3262

Export Sales Organisation: Associated British Machine Tool Makers Ltd., London, Branches and Agents.

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Swinging to Clayton

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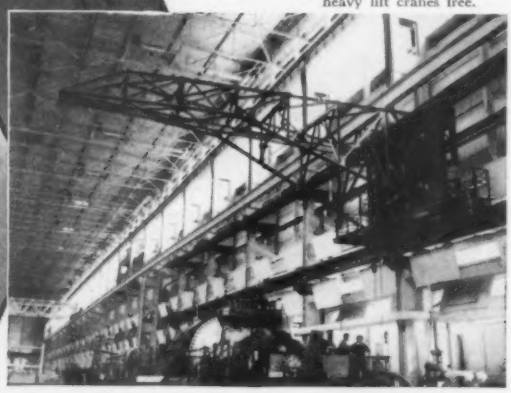
MORGAN CRUCIBLE CO. • HEINZ
BRISTOL AEROPLANE CO. • FORD
BRITISH THOMSON-HOUSTON

This picture shows one of two Clayton wall cranes especially designed to fit into a handling scheme used in the turbine assembly bay of British Thomson-Houston Ltd. Two overhead electric travelling cranes of 75 and 150 tons capacity, on gantries one above the other, take care of the heavy lifts involved in turbo construction and the two travelling wall cranes are provided for general assembly work on the turbo alternators, thus leaving the heavy lift cranes free.



In addition to the above equipment over 100 Clayton Electric Hoists have now been supplied. 80 of 2 tons capacity are fitted on radial jib cranes and most of these have the Clayton micro speed units for precision handling.

Big manufacturers are pretty cool cats when it comes to crane buying. Habitually their standards are as exacting as their demands are imperative. Sizeable cool cats don't swing for nothing, and the Clayton organisation doesn't intend to fall short of what it takes to keep 'em swinging.

MAY WE SEND YOU CATALOGUES?

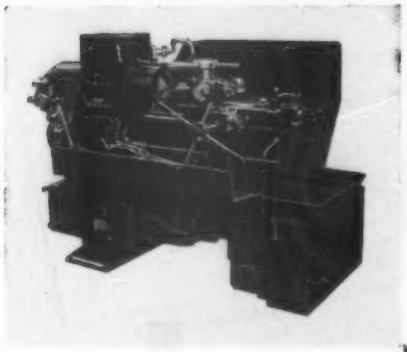
REGISTERED TRADE MARK
CLAYTON

CLAYTON CRANES

AND ELECTRIC HOISTS

THE CLAYTON CRANE & HOIST CO. LTD.,
(DEPT. 10) IRWELL CHAMBERS EAST · UNION ST · LIVERPOOL
Telephone: CENtral 1141 (4 lines) · Telegrams: Claymag, Liverpool

London Office:
12 *Duke Street, St. James's, S.W.1. Telephone: Whitehall 6988*



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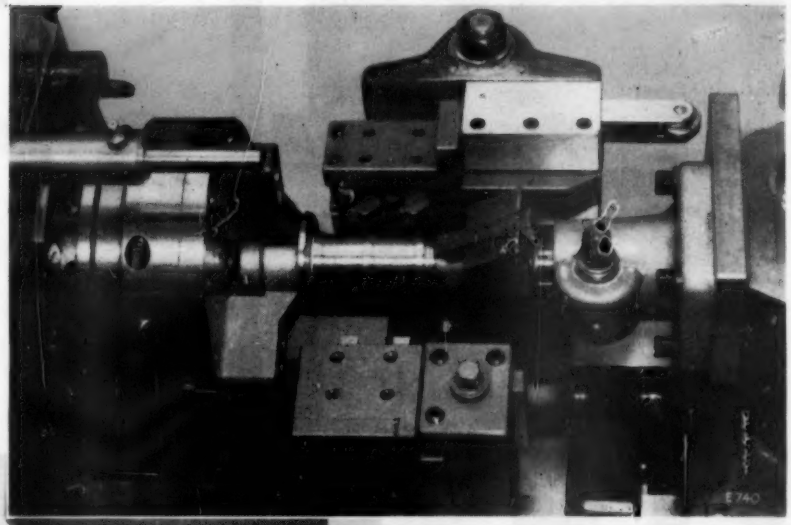
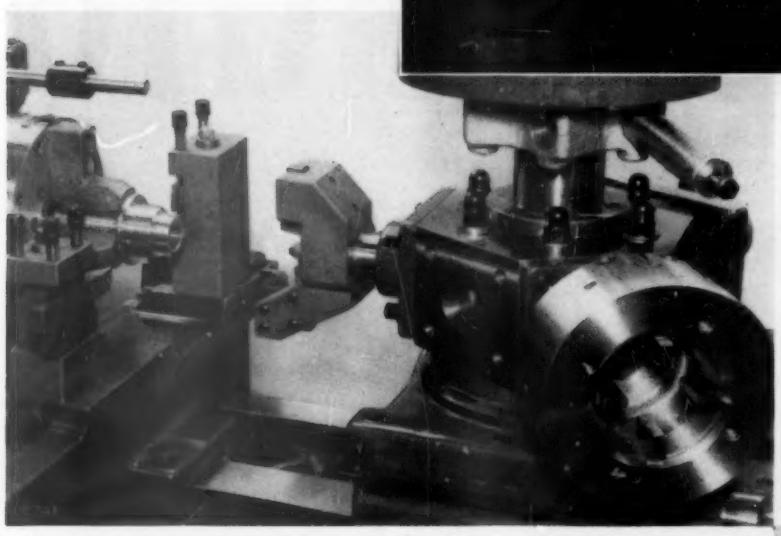


First operation for producing fire hose couplings from brass pressings on a machine fitted with a special cross-slide and profiling slide.

The tools on the profiling slide are fed forward by operation of the cross-slide while the component is supported in the bore by a revolving steady. The turret is then moved forward to actuate the profiling slide and so turn the two 32 mm. diameters simultaneously. Continued movement of the turret radiuses the end and chamfers the bore.

Floor to floor time—12 seconds.



In the second operation on the couplings, the 42mm. diameter, the taper, the radius on the end and the chamfer in the bore are simultaneously machined with tools held in a standard combined holder on the turret.

Tools held on the cross-slide are then used to radius the flange, undercut and chamfer the thread diameter and undercut the taper. The 42 mm. thread is cut with a 2½ in. Solid Adjustable Diehead mounted on the third turret face.

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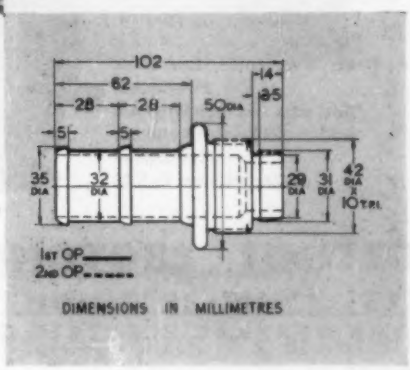

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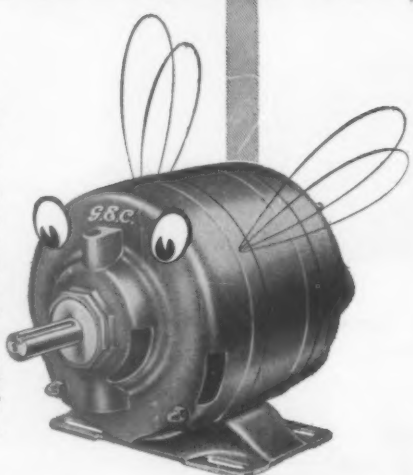

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Subject: CONTROL GEAR PUBLICITY

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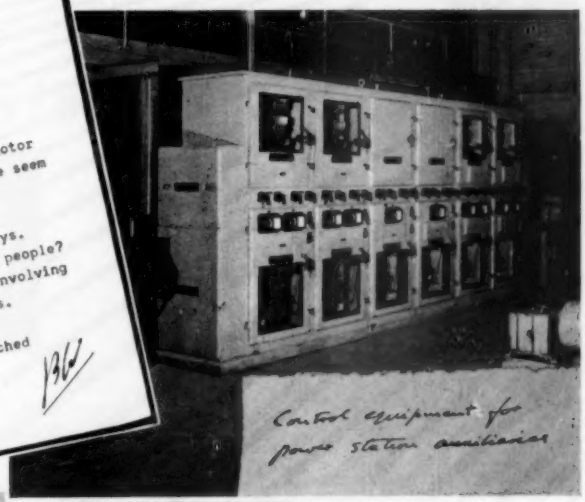

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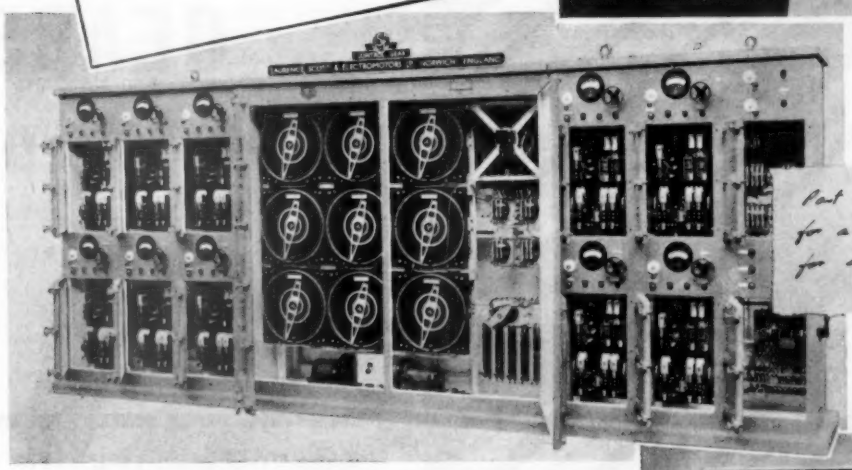

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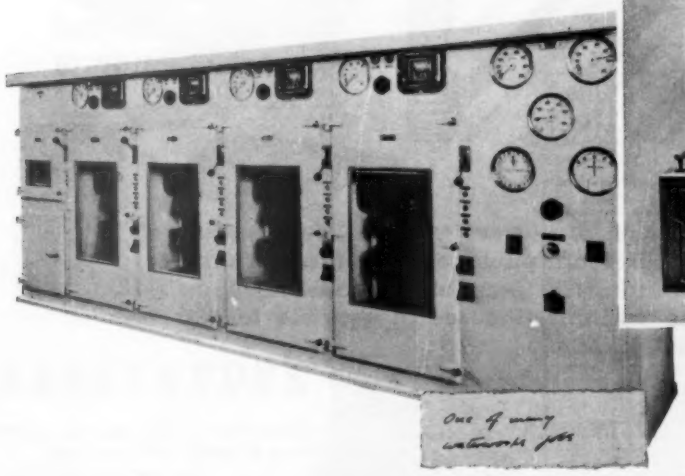

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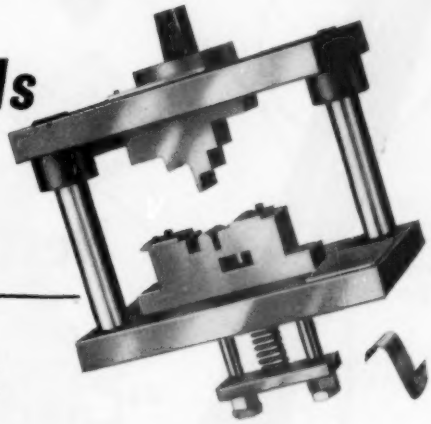

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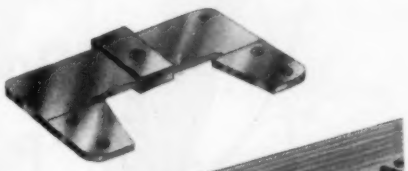

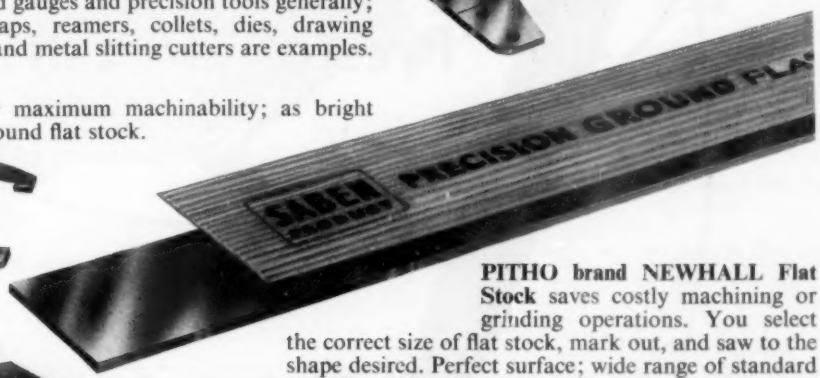

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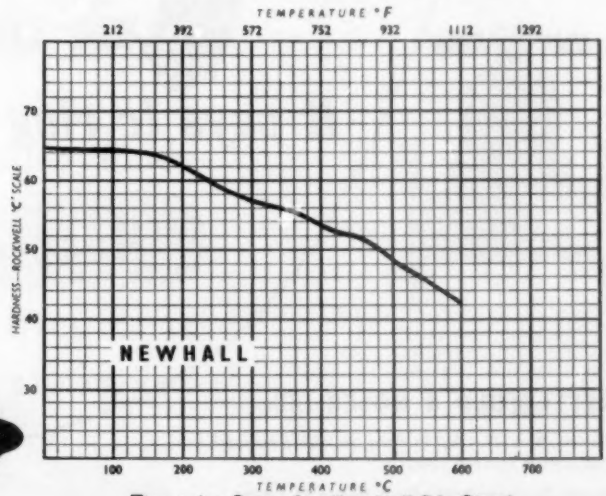

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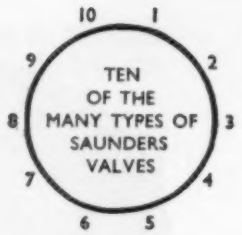

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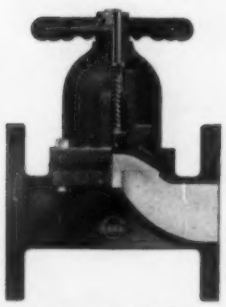

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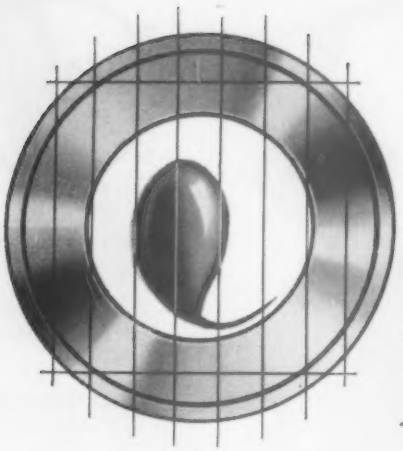

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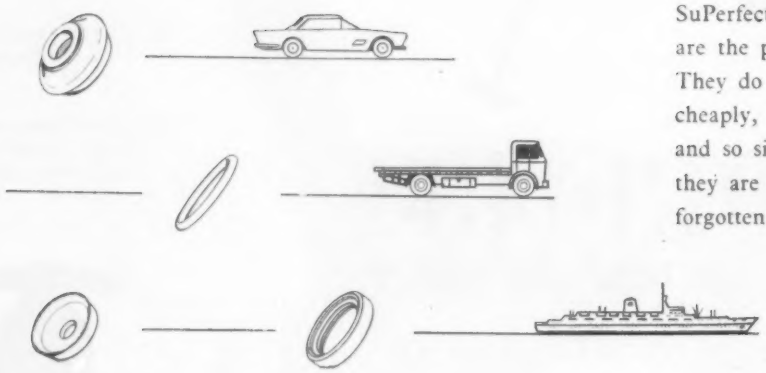

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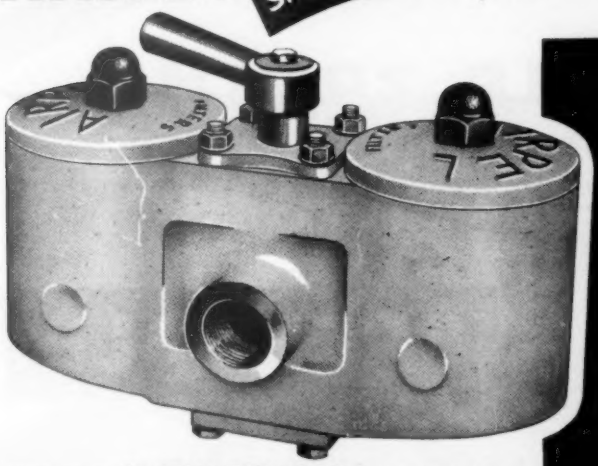

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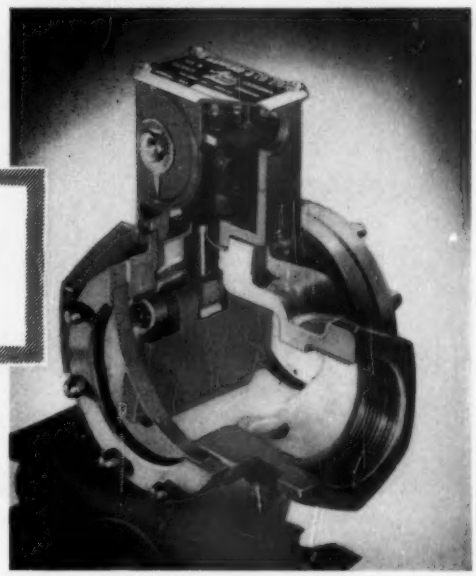

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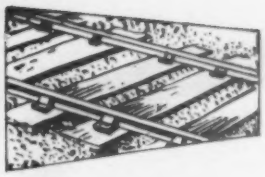

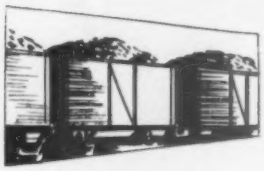

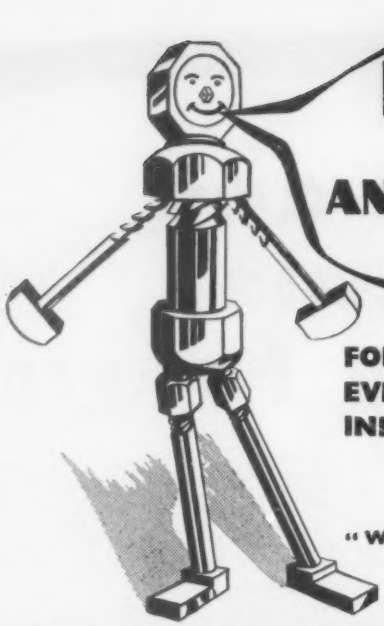

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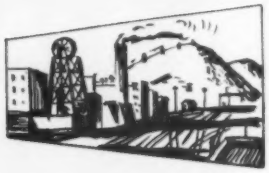

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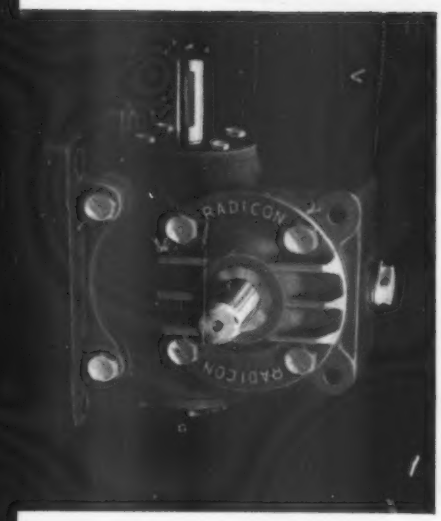

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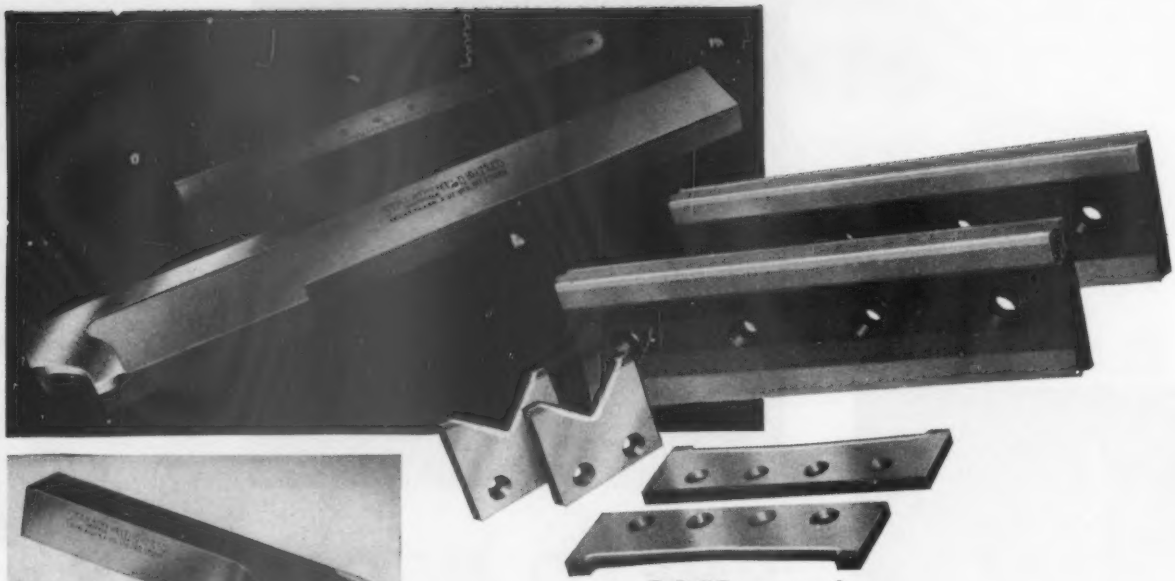

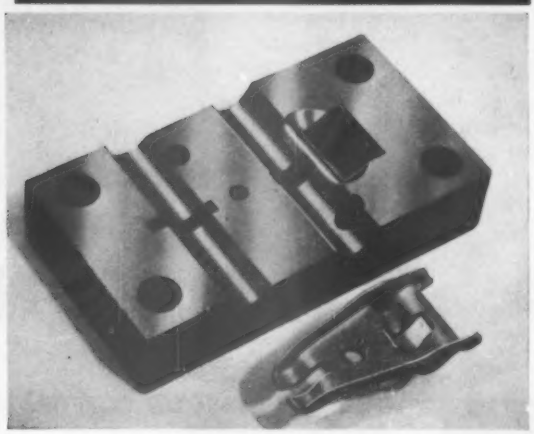

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Mechanical World

AND ENGINEERING RECORD

Vol. 140 JANUARY, 1960 Number 3486

Contents

Editorial: Challenge of the Sixties 1

Log Sheet: Stainless Steel Cladding. Acoustic Laboratory. First 200MW Turbo Generator. Resin-bonded Brake Liners. Longridge House. Electronic Forum. Computer Break-through. Mechanized Marshalling Yard. Largest British Hammermill. Glass Fibre in Strip Pickling Line. Tufplas Tank 2–5

Rolling Curves and Non-circular Gears by W. H. Sheppard, B.Sc.(Eng.) 6–11

Mechanical Engineering Research
Work at East Kilbride on metal extrusion, noise reduction in pipes and steam condensation 14–15

Speed and Accuracy in Machining
Illustration of modern machine tool performance 15–18

Earth Leakage and Earth Fault Protection-III by J. L. Watts
Fault current from other systems and earthing circuits 20–23

technique: Metal Powder Tools Reduce Vibration. Fan Performance Recording Outfit. Making Wire-covered Plastic Hose. Removing Tight Keys. Economical Rig for Boring Bush Housings 24–25

Some New Alloy Metals
Research periodically produces new alloy metals of industrial importance. Some of these alloys are described and the purpose behind their development suggested..... 27–28

Nuclear Marine Propulsion in Russia, France and Japan
by J. R. Finniecome, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer.
Some Russian and French projects were dealt with in our December, 1959, issue. Here the author concludes his survey, and deals with Japanese nuclear marine plants..... 30–33

Atomics:
Control of Radioactive Wastes. Steam Raising Units at Hinkley Paint. Reactor Alignment and Fuel-charge Handling. Dounreay's "Hot" Laboratory. Dual Reactor Power Plant. Burst Slug Detection Equipment. Low-level Beta Counting..... 34–35

Business and Professional: Personal. Obituary. Addresses. Business Notes. Trade Literature. New Factories 40–46

Product Reviews: Vertical Bending Rolls, **11.** Lacquer Finish for Aluminium, **11.** New Matrix Jig Grinder Works Hardened Material Without Distortion, **12.** New 60 bhp Industrial Diesel, **13.** Metal Laboratory Furniture, **18.** Low Cost Vacuum Treatment, **19.** Twelve-inch Level, **19.** Double Acting Fuid Seal, **19.** New Besco Plate Bending Rolls, **23.** Silicone Rust Inhibitor in Aerosol Container, **23.** New Line Earth Loop Tester, **26.** New Desiccants for Moisture Control, **26.** Bench Pantograph, **26.** Fully automatic Scales, **28.** Oxygen Profiling Direct from the Drawing, **29.** Electrically Controlled Tube Expander, **29.** Worm Drive Mining Hydraulic Pump, **33.** Spark Machining, **36.** Packing Components in Plastic, **37.** Anti-vibration Nut, **13.**

Books ..... 38–39 **New Standards** 39

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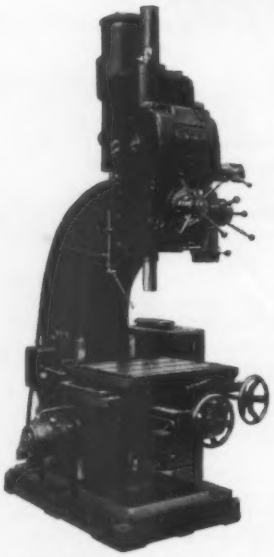
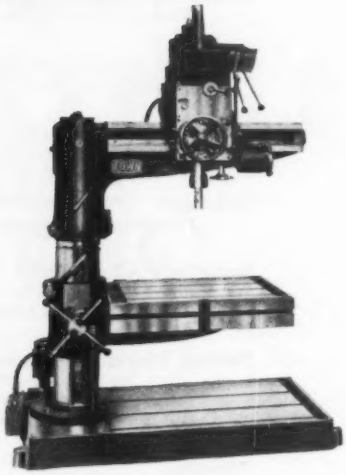
MODEL CE2: RADIAL DRILLING, BORING, TAPPING and STUDDING MACHINE. Four sizes: 5′ to 8′, 18 speeds; 15-850 r.p.m.; drills 3½″ from solid in mild steel.

MODEL AE4: RADIAL DRILLING, BORING, TAPPING and STUDDING MACHINE. Seven sizes: 3′ 6″ to 8′; drills 3″ from solid in mild steel.



MODEL AE2: VERTICAL DRILLING MACHINE (Heavy-duty model). Two sizes: 36″ and 42″; drills 3½″ from solid in mild steel.



MODEL AE5: RADIAL DRILLING, TAPPING and STUDDING MACHINE. 42″; drills 1¾″ from solid in mild steel or 1½″ in cast iron.

MODELS EG4, and EG8, GIRDER RADIAL DRILLING MACHINES. Each model in five sizes: 4′ to 8′. 4 speeds: 160-600 r.p.m. (EG4), 8 speeds: 20-500 r.p.m. (EG8) drills up to 2″ from solid in mild steel. Also made with single speed.

OTHER MACHINES IN THE RANGE

are detailed in a folder 'GO TO TOWN' which is available on request. Variations on the standard range can be undertaken, and examples are also illustrated in the folder.

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Mechanical World —— January 1960

Challenge of the Sixties

THE new decade has begun auspiciously. There are signs everywhere of a recrudescence of engineering activity, or rather of recovery to the full stretch of expanding effort that was in evidence before the several dampening effects of the last two years so coincided as to produce a diminution of activity. For progressive development cannot proceed without the stimulation, these days, of world wide trade and development. A feature of recent months has been the appearance of many projects for complete plants on the largest scale in various parts of the world—plants which will embody the latest that technology has to offer in the promotion of productivity and which will greatly alter the economic circumstances of the communities in which they are sited. This is almost certainly the beginning of the pattern of this new decade—the know-how, the machinery and the material of the industrial world spreading over the whole face of the globe, carrying with it a new standard of living and the means of securing health of mind and body for all. The aspirations of man which have so often in the past been deflected uselessly to destruction have now illimitable opportunity of achievement in the present entry into the nuclear and space age. An expansive influence is ever required by an industrial community. In the past the railway, the motor car and the aeroplane have served, each for a time, but these are small by comparison with what is now in prospect. In the past, ignorance among so many and the lack of means of amending this has been a major limiting factor, but with the most modern methods of communication spreading at an unprecedented rate it must soon cease to matter. It remains for the most advanced countries to show the way; the challenge is no less than the highest peaks of scientific and industrial achievement—of escape from the bondage of the earth.

LOG SHEET

Stainless Steel Cladding

Extensive use of stainless steel has been made in the construction of a new two-storey chemical laboratory at the Stocksbridge works, near Sheffield, of Samuel Fox and Company, Limited, a subsidiary of The United Steel Companies, Limited.

An outstanding feature of the building, which centralizes the work previously carried on in several separate laboratories, is the employment of stainless steel as an external wall cladding. The wall panels consist of 26 gauge stainless steel sheets, diamond patterned, and electro-polished to a matt finish which prevents glare and reflectivity. The sheets are bonded to half-inch Asbestolux board. The steel is Silver Fox 20, containing 18% chrome and 8% nickel.

The curtain walling was supplied and erected by the Crittall Manufacturing Company Limited, and is one of the first examples of their Fenestra 237 system, which makes use of Neoprene as a bedding material, thus eliminating much of the caulking work associated with conventional systems.

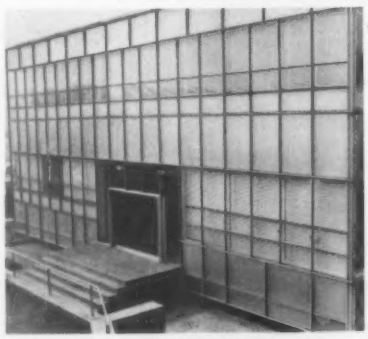
Another interesting feature of the curtain wall is that the main structural extrusions are horizontal and are positioned where a horizontal division is predetermined by the ceiling and sill heights. This gives freedom to the architect to position the vertical members where they are best suited for spandrels and glazing, and has enabled the number of wall panel sizes to be kept to a minimum.

Internally, the building contains many examples of practical applications for stainless steel, including the stair balustrade, lift gates, push and kicking plates, door furniture and oil fuel extraction hood.

The new laboratory is the second building at the Stocksbridge works to have stainless steel external wall cladding. The first building, a melting shop administrative block, was erected in 1954, and the panels are still in perfect condition today, there being no sign of corrosion, despite close proximity to the corrosive atmosphere of a steelworks. In this example, the wall panels were designed to give rigidity and so required no backing, a method which is particularly suitable for large buildings where a high tool cost can be absorbed and its cost equalized against the saving on backing material.

In order to test the relative corrosion resistance of various stainless steels some of the panels in the administrative block were made from a molybdenum-bearing alloy (Silver Fox 316) but in fact those made from the more economical 18% chromium, 8% nickel steel have stood up equally well to the arduous atmospheric conditions and this quality was thus adopted for use in the new laboratory.

It is planned to employ the same cleaning technique on the laboratory as is already used on the existing building. This is for the window cleaners to wipe the panels down



Stainless steel external wall cladding is a feature of the new laboratory of Samuel Fox & Co.

with a wash leather once a quarter, at the same time as they clean the windows. (The windows alone are washed once a month). This ensures that the considerable dust that is constantly blowing about a big steelworks does not build up on the panels and spoil their interesting metallic sheen.

Acoustic Laboratory

Acoustical Investigation and Research Organization Limited is the first independent, non-trading organization to be formed in the British Isles for the purpose of practical investigation and research into all aspects of noise. Its consultative services are available to industry on a fee-paying basis and it endorses with a written undertaking the results of any findings or recommendations it is required to make. It maintains close liaison with the National Physical Laboratory, Teddington, and the Building Research Station, Garston, Watford. AIRO's Research Station at Hemel Hempstead has been designed to comply with the recommendations of these two authorities.

The new laboratory is the first in this country to bring under one roof all the special equipment and techniques necessary for acoustic analysis and measurements of every description. The laboratory will undertake the measurement of acoustic characteristics of machines, materials and electro-acoustic transducers, development projects and fundamental research.

The laboratory consists of four experimental chambers and an underground duct. All are connected to the control room, to which information is transmitted for recording and analysis of the data obtained. Two of the test rooms require maximum insulation from extraneous noise: these are the anechoic or echo-free chamber, and the reverberation chamber where all surfaces reflect noise. Both are separately supported on high-compression rubber mountings and are completely independent of the structure of the building. In addition, incoming ducts and leads are insulated and a mineral wool blanket is suspended in the cavity between these chambers and the main structure.

In the anechoic chamber there is a sound-absorbent lining on all walls, floor and ceiling. This consists of "Bondacoust" in a specially devised formation, up to a thickness of 30 in. There is a retractable metal grid floor which is used for setting up experiments. In the reverberation chamber all surfaces are reflective and adequate diffusion of sound is obtained by introducing reflector plates suspended from the ceiling. This technique has not been used previously in Britain and is now internationally accepted.

In the ceiling of the reverberation chamber there is a pre-cast concrete panel which can be raised by hoist into the upper source chamber above. It can then be removed along a gantry and lowered to ground level for resurfacing with new materials which require to be tested for sound transmission properties.

No two walls in the reverberation chamber are parallel to one another,

the object being to prevent undesirable effects associated with rectangular rooms. The same requirement applies to the source chamber which although not suspended independently, has highly-reflective surfaces and no two walls in parallel.

The underground duct, which is adjacent to the building is 40 ft long by 3 ft. square. It contains an anechoic wedge structure which can, when required, be blanked off by reflective plates.

The AIRO headquarters are at 118 Cromwell Road, London SW7.

First 200MW Turbo Generator

Europe's first 200,000 kW steam turbo-generator unit was successfully put into service by the British Central Electricity Generating Board at High Marnham Power Station on October 15th. The new turbine and alternator were the largest ever to leave the Rugby and Stafford works of The English Electric Company Limited. The turbo-alternator was also the first tandem 200,000 kW unit to be manufactured in Britain and is typical of the most advanced designs now in course of manufacture in English Electric's works where the largest turbo-alternators now on order are the 275,000 kW reheat sets for the Blyth-B Power station of the C.E.G.B.

The 1000 MW High Marnham Power Station when completed, will contain five sets of 200,000 kW English Electric generating equipment and will be the largest station yet to be built in Britain. The five units will be arranged in line along the turbine hall at 120 ft centres. The total weight of one turbo-alternator is 1,450 tons, the heaviest component being the alternator stator at 168 tons.

For this unit, The English Electric Company Limited designed, developed and built the 200 MW, 3,000 rpm reheat steam turbine with its feed heaters at its Rugby works, while the turbine's condensers were built at its Netherton works. The company's Stafford works supplied the 200 MW direct hydrogen cooled 3,000 rpm alternator and main exciter, the main 210 MVA generator transformer, the 17·5 MVA unit transformer, the 22·5 MVA station transformers and the induced draught fan motors, the appropriate control and supervisory equipment

RESIN-BONDED BRAKE LINERS.—These large brake liners, used by the National Coal Board for mine shaft lifting gear, are 13 ft 5 in. long and 19 in. wide. The 1 in. thick sections of woven asbestos and cotton are bonded with 'Redux' resin adhesive to the metal; four sections are required to cover the circumference of the braking wheel mechanism. 'Redux' is best known as an adhesive for metal aircraft structures but it is being increasingly used for bonding brake liners for industrial machinery as well as for motor vehicles. Mercedes-Benz and Citroen cars employ this adhesive for their brakes and in this country several companies operating buses and taxicabs are taking advantage of the economies offered by the bonding technique

were built at its Liverpool and Kidsgrove works and the control exciter and smaller fan and pump motors at its Bradford works.

Longridge House

Engineering insurance has been providing technical and insurance service to industrialists and other users of power plant for over a century. The extent to which engineering insurance has grown, in keeping with the ever increasing mechanization in industry and other walks of life, is typified by the "British Engine" new head office building—Longridge House—perpetuating the name of the company's founder and which has become a new landmark in Manchester.

The "British Engine", which is the largest of the specialist companies, occupies nearly the whole of this big building the unusual shape of which was dictated by the site boundary. It is of steel-framed and concrete fireproof construction and has a basement, ground and seven upper floors. The elevations are faced with Westmorland green slate, with Portland stone dressings chosen in an endeavour to preserve colour and self-cleansing texture in a city atmosphere. The building has been designed to give the maximum daylight to all departments. It is heated throughout by Frenger ceilings, in which low-pressure hot-water coils are enclosed in perforated panels, giving not only well-distributed radiant heat but also high sound-absorbency. The boilers are oil-fired and thermostatically controlled; the building is divided into a series of circuits according to aspect, and changes in outside temperature on any face bring the appropriate thermostatic controls into operation. Fluorescent lighting incorporated in the ceiling panels gives maximum distribution with minimum dust collecting surfaces.

The construction has been by John Laing & Sons under the direction of Harry S. Fairhurst & Son, architects.

Electronic Forum

A little over a year ago, several representatives of the branches of industry particularly concerned with data processing and control got together to discuss how, by united effort, they could encourage the adoption of new methods throughout industry. After an exploratory meeting the Electronic Forum for Industry was founded, and an inaugural meeting held in February, 1958.

The Forum was conceived as a means of projecting to all users and potential users of electronics equipment the wide and varied scope of the electronics industry, and receiving from them inspiration and guidance on new uses, and the improvement or modification of established applications. With this end in view the following eight associations became constituent members of the Forum: British Electrical and Allied Manufacturers Association, British Radio Valve Manufacturers Association, Electronic Engineering Association, Machine Tool Trades Association Inc., Office Appliances and Business Equipment Trades Association, Radio and Electronic Component Manufacturers Association, Scientific Instruments Manufacturers Association, Telecommunication Engineering and Manufacturing Association.

First and foremost, E.F.F.I. is intended to bridge the gap at present existing between the fast-expanding electronics industry and the growing number of user asociations, and to assist technical committees in interested associations, whether or not they are members of the Forum.

E.F.F.I. makes available to those who wish to tap it, a vast pool of technical knowledge. An advisory committee (known as the Electronic Forum Advisory Committee) has been formed with the purpose of advising and assisting users in industry generally with reference to the progress and development of

techniques in the use of electronic equipment. The address is 11 Green Street, London W1.

Computer Break-through

A new high-speed electronic data-processing system known as Orion, claimed to be one of the fastest and most powerful of its type in the world, is currently under development by Ferranti Limited. Construction of the prototype is well under way and work has commenced on the first production models. The new system is fully transistorized and incorporates the latest Neuron logical elements enabling complex systems to be built around the central computer with the minimum of components.

A large computer is more economical than several smaller machines doing the same volume of work. The problem has been to keep a large machine and its equipments working at full capacity. In Orion, this difficulty is overcome as full facilities are provided for automatically sharing the time of the central computer between several programmes. This time-sharing system ensures that the computer is always fully engaged even while peripheral transfers take place and that peripheral equipments are kept working at maximum speeds. This is done by special equipment which selects programmes according to given priority levels. This priority-processing is fully automatic.

Notable features of Orion are automatic safeguards known as lock-outs and lock-ins, which ensure that programmes in the computer cannot interfere with each other and confine the programme in use to its own part of the computer. An unusually large number of different devices can be attached to the computer and there will be a unifying method of attaching them. Transfers of information to and from the peripheral equipments can be carried out concurrently, but a new technique enables this to be done without using buffer stores.

The computer has a magnetic core working store of capacity between 1,024 and 16,384 words, depending on requirements. The store is backed by a number of magnetic drum units which are treated as peripheral devices. It will also have a comprehensive order code with full facilities for automatic modification of addresses and for indirect addressing. Instructions will be of the two or three address type. Speed of addition and subtraction will be 36 to 68 microseconds, multiplication 60–200 microseconds and division will take 300–900 microseconds. Fast floating-point operations will also be available.

Magnetic tape will be processed at very high speeds. For example, 4½ million words can be read or written by the computer per minute. Various high-speed printers can be attached including the Xeronic, which can produce up to 3,000 lines of finished data per minute.

Although smaller in size, Orion will be up to 20 times faster than Perseus, at present the largest data-processing system manufactured in Europe and three to four times as fast as Mercury, the fastest computer in Europe.

Developed primarily for commercial data processing, the flexibility of the system makes it equally suitable for scientific research and technical calculations. Research and development of Orion has proceeded in parallel with Atlas, a large capacity, very fast transistorized computer for scientific applications, at present under construction.

It is anticipated that the price of the system will generally fall within the range of £100,000 to £300,000 depending on size and scope of the installation.

Mechanized Marshalling Yard

The modernization and rationalization of the railway equipment at the important railway centre at Perth centre round the provision of a new mechanized marshalling yard and of an up-to-date power signalling installation. An incoming train will enter one of a group of six reception lines, where the locomotives will be detached. From there it will be drawn by a diesel shunting engine to a headshunt, where the wagons will be examined, uncoupled and listed according to destination. The list will be passed by pneumatic tube to an operator sitting at a console in an elevated control tower, who will press a series of keys to transfer to punched tape the siding numbers into which the wagons are required to pass.

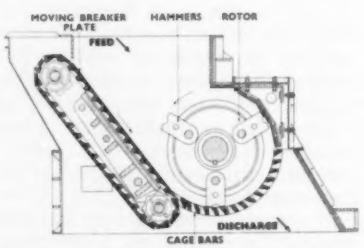
The train will then be propelled over a "hump", the individual wagons or "cuts" separating as they pass on to the falling gradient. Points will operate automatically to direct the wagons into the appropriate sorting siding, whilst their rate of progress will be regulated by the use of retarders or rail brakes. These also operate automatically and pay due regard to the weight and speed of the wagons, their running characteristics and the distance they have to run until they buffer up gently to the last wagon in the siding. Whilst both points and retarders operate automatically, the operator in the control tower can take over-riding action if necessary, all controls being concentrated on the console at which he sits.

There will be thirty double ended sorting sidings in the main yard, and this number will enable the majority of the wagons to be directed on to the appropriate outgoing trains without any further shunting. Two small groups of secondary sorting sidings will be provided to enable local trains to be made up into proper order for serving a series of wayside stations, etc. Trains will be able to depart direct from the new yard, either to the north or the south.

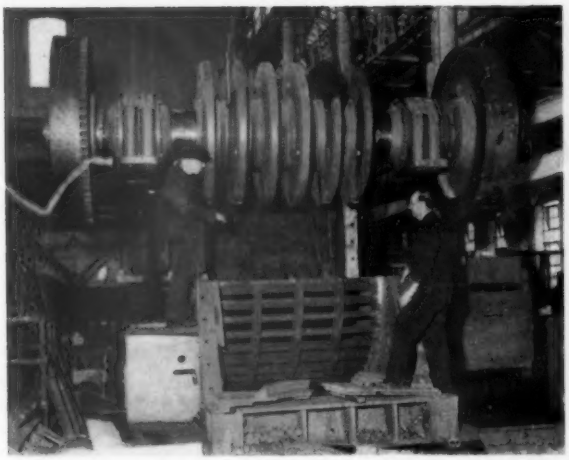
The electro-pneumatic wagon speed retarding equipment is being supplied and installed by the Westinghouse Brake & Signal Company Limited and includes air compressors and electronic equipment.

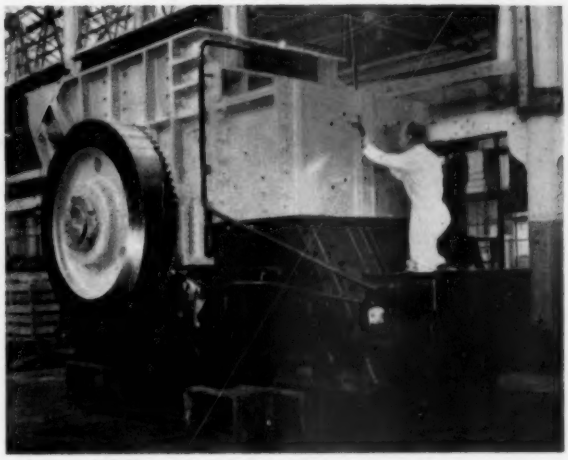
Largest British Hammermill

The largest swing hammermill ever to be built in Britain, has recently been completed in the Erith Engineering Works of The General Electric Company Limited of England for installation in the quarry of Adelaide Cement Company Limited, South Australia. It is a 72 in. × 60 in. Pennsylvania-Dixie non-clog hammermill Type DNC and is capable of taking pieces of rock as large as 48 in. and breaking them all below 1 in. at the rate of over 350 tons per hour.



Section of Dixie Non-Clog Hammermill, Type DNC





Left, the rotor of the hammermill being dropped into position. The cage bars are underneath it and the moving breaker plate can be seen at the back. Right, the 72 in. × 60 in. hammermill erected in the Erith Works of the G.E.C. previous to despatch

The machine works on the principle of a conventional hammermill, the material being crushed by revolving hammers against a breaker plate and swept through cage bars at the bottom to give a product of finished size. The rock at Adelaide Cement Company's quarry contains clay, which, when wet, would tend to stick in the feed opening, eventually blocking it completely. The Dixie Hammermill is specifically designed to meet conditions such as this. A downward-travelling breaker plate is provided to pull the sticky material continuously down into the crushing zone of the hammers, where it is broken up and forced through the cage bars. The moving plate effectually prevents any tendency for the feed opening to become choked.

The crusher frame is of welded construction. The breaker plate, which weighs 7 tons, is made in two halves for convenience in manufacture and installation, each half consisting of a series of manganese steel plates linked together to form an endless chain. Plain trunion wheels support the links at the top, and they are driven from the bottom by toothed sprockets wheel connected to an independent motor through a reduction gearbox. The breaker plate is backed by a massive steel bedplate of welded construction, the purpose of which is to give solid anvil crushing under heavy shock loading. The breaker plate can be regulated not only for tension but can also be adjusted as a unit with the bedplate at any desired clearance from the hammer tips. The interior of the mill is protected by liners cut from special wear-resistant manganese plate.

The rotor shaft, which is made of chrome-molybdenum steel, carries, shrunk on to it, six discs each 3½ in. thick, from which the hammers are suspended. The whole assembly with the hammers, flywheels, bearings and a half-coupling weighs just over 25 tons. It has a direct motor drive through a flexible coupling. The shaft is carried in SKF self-aligning roller bearings fitted with a thermostatic control which stops the machine in the event of the bearings overheating. The bearings are lubricated by means of an oil circulating system. Bearings, flywheels and the driven half-coupling are mounted on the shaft on taper seatings by means of the SKF oil-injection system, no keys being necessary.

The whole mill is of massive construction and weighs 70 tons complete. The rotor assembly is driven by a 650 hp motor, a separate 15 hp motor being provided for driving the moving breaker plate.

Glass Fibre in Strip Pickling Line

Glass fibre reinforced plastic covers are now being used on strip pickling lines at the Abbey Works of The Steel Company of Wales Limited. No metal reinforcement is used in their construction and they replace rubber-coated steel covers which had been found unsuitable due to corrosion problems.

The main difficulty to be overcome on this pickling plant was that acidic vapours and the splashes from the sheet steel as it passed through a liquid containing 25% sulphuric acid corroded the steel covers and caused dangerous weaknesses for operators who may have to walk over them. Glass fibre reinforced plastic proved the most suitable alternative material to meet this requirement and also provided an additional safety factor in that the surface is non-skid and easy-to-clean.

On No. 2 pickle line at Abbey Works, each Permali glass fibre cover measures 13 ft × 9½ ft and weighs about 600 lb, polyester resin accounting for over half this total weight. They are designed to provide maximum rigidity with lightness and are made of double-skin construction with an internal glass fibre "honeycomb" reinforcement. Glued joints were avoided by completing the whole manufacturing lay-up operation without a pause. Rubber strip is bonded around the edges of each cover to prevent sulphurous gases escaping from the pickling tank.

Tufplas Tank

The Mullard Radio Valve Company Limited use de-ionized water at their Mitcham factories for washing the component parts of radio valves. Recently they have had a 3000-gal tank installed to store the water, and this tank made by Cawley Plastics Limited, of Weybridge, is believed to be the largest yet made in "Tufplas", a chemically bonded laminate of unplasticized P.V.C. and chemical grade polyester resin reinforced with glass fibre. The tank is cylindrical and 13 ft high and 7ft dia.

Rolling Curves and Non-circular Gears

By W. H. SHEPPARD, B.Sc. (Eng.)

IN the design of machinery and instruments it is often necessary to vary the velocity ratio between two members and wide use is made of linkwork, cams, gears and the like. The development of cams is thoroughly understood. Rolling curves, however, which broadly speaking form a special case of cams, are not so common and non-circular gears which are derived from rolling curves are often avoided.

The use of non-circular gears has become of increasing importance of recent years in the generation of functions for computers, uniform scale gears and the like. Linkwork may sometimes be used for these purposes but if the design of appropriate non-circular gears is first considered, the two may often be combined to advantage.

This article gives the result of an investigation into the subject. The general case of two rolling curves is first considered in theory and then two curves rolling without sliding regarded as a special case. Broadly speaking there are three types of design problem involved as explained in Sections I-III, and these may be handled mathematically or graphically as indicated. Standard forms are then discussed with their special applications either as rolling curves or non-circular gears.

With regard to rolling curves, pure rolling is considered in this article, but this should not be confused with the flanks of gear teeth which are rolling and sliding surfaces. These are well understood and explained in standard works.

Fundamental principles

The theory of rolling curves and non-circular gears will first be considered together, the latter being regarded as rolling curves along their pitch lines. Referring to Fig. 1 which represents the general case of two curved surfaces in contact at point P and capable of rotation about the points O and Q respectively, if the driver is rotated about its centre, the follower will tend to rotate in the opposite direction.

Let the polar equation of the driver be $a = F(\theta)$
Then if Ω = angular velocity,
actual velocity $V = a\Omega$ *or* $\Omega = V/a$

Let polar equation of follower be $b = f(\phi)$
Then if ω = angular velocity,
actual velocity $v = b\omega$ *or* $\omega = v/b$

$$\text{Velocity ratio} = V.b/a.v = (V/r)/(b/a)$$

$$\text{Common normal velocity } v' = V' = V\sin\theta' = a\Omega\sin\theta'$$

$$\text{Then } v = v'/\sin\phi' = a\Omega\sin\theta'/\sin\phi'$$

$$\text{and } \omega = a\Omega\sin\theta'/\sin\phi'$$

where $\theta' = \theta + \alpha$, $\phi' = \phi - \alpha$,
and α = inclination of common tangent.

The tangential velocities are given by

$$\text{Driver } V'' = V\cos\theta' = a\Omega\cos\theta'$$
$$\text{Follower } v'' = v\cos\phi' = b\omega\cos\phi'$$

Then rubbing velocity $= V'' - v'' = a\Omega\cos\theta' - b\omega\cos\phi'$

For pure rolling, i.e. without sliding, rubbing velocity $= O$ and $a\Omega\cos\theta' = b\omega\cos\phi'$

This can only be satisfied by $\cos\theta' = \cos\phi' = 1$
i.e. $a\Omega = b\omega$

whence the point P must be on the straight line between the centres of rotation O and Q.

I. To design the follower to suit the driver

(*a*) *Theoretical calculation*

Let $a = f(\theta)$ be the polar equation of the driver.
Inclination of the tangent is given by

$$\tan\alpha = da/ad\theta = f'\theta/a$$

Inclination of the tangent of the follower is given by

$$\tan\alpha = \frac{db}{bd\phi} = -\frac{f'\theta}{(s-b)}$$

$$\text{whence } \phi = -\int \frac{(s-b)}{bf'(\theta)}db$$

from which b may usually be determined in terms of ϕ.
The velocity ratio is given by

$$VR = b/a = (s-a)/a$$

which gives an alternative method of determining the equation for the follower by the method in the next section.

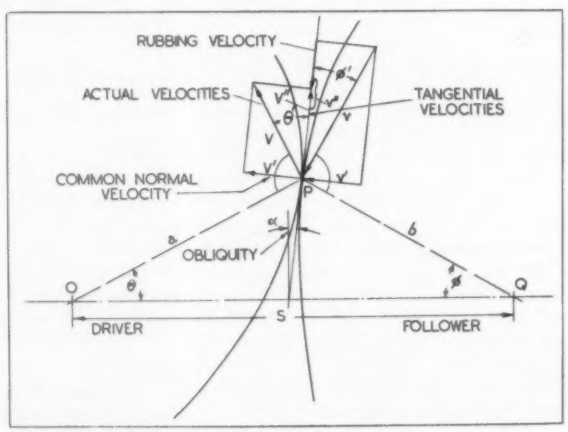


Fig. 1.—General case of two curved surfaces rolling in contact

Example:

$$a = Ae^{n\theta}$$

$$da/d\theta = Ane^{n\theta} = na = n(s-b)$$

$$\phi = -\int \frac{s-b}{bf'(\theta)}db$$

$$= -\int \frac{s-b}{bn(s-b)} = -1/n\int 1/b.\,db$$

$$= -1/n[Log\ b+C]$$

If $\phi = O$, $b = B$, and $C = -Log\ B$.

$$\phi = -(1/n)\ Log\ (b/B) \text{ or } b = Be^{-\phi n}$$

which is a similar equation to that of the driver.

Since $da/d\theta = na$, $n = (1/a)(da/d\theta) = tan\ \alpha$ where α = obliquity of common tangent.

Then $a = Ae^{\theta tan\alpha}$ and $b = Be^{\phi tan\alpha}$

(In the latter case B is the maximum radius and ϕ is negative).

These gears may with advantage be made identical in which case

$A + Ae^{2\pi tan\alpha} = s$, the distance between the centres.

then $A(1+e^{2\pi tan\alpha}) = s$ which may be solved for A or α.

The velocity ratio is given by

$$V = b/a = Be^{\phi n}/Ae^{\phi n} \text{ or } (s-Ae^{n\theta})/Ae^{n\theta}$$

$$= (B/Ae^{n(\phi-\theta)} \text{ or } s.A.e^{-n\theta} - 1$$

(*b*) *Graphical Construction*

If the expression for the follower cannot be integrated or if the expression for the driver is given as a series of polar co-ordinates, the shape of the follower may be determined as follows:

Referring to Fig. 2, the pitch line of the driver is divided into short equal distances and the increment of radius measured at each point and subtracted from the radius of the follower, striking off pitch line distances equal to that of the driver.

This method is particularly suitable if further adjustment is required. For example, if two identical square forms are required, one may be drawn with the pitch line radius increasing and decreasing sinusoidally and the other to suit. Then both may be adjusted until they are identical.

Alternatively, the shape of the follower may be determined graphically from the velocity ratio of the driver as explained in the next section.

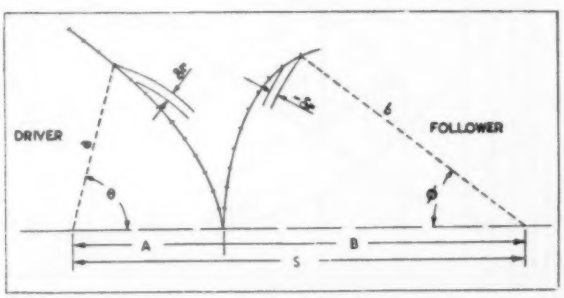


Fig. 2.—Graphical determination of shape of follower

II. To design the driver and follower to a particular velocity ratio

(*a*) *Theoretical calculation.*

In this case let V.R. $= f(\theta) = b/a = (s-a)/a$

For the driver $a1' = s-a$

then $a = s/(1+V)$

For the follower $ad\theta = bd\phi$

$$\phi = \int (a/b)d\theta$$

$$\phi = \int (1/V)d\theta$$

Alternatively the equation for the follower may be determined from that of the driver using the method of Section I.

Example 1.—

Let $V = n\theta$

$$a = s/(1+n\theta)$$

$$\phi = (1/n)\int (1/\theta)d\theta$$

$$= (1/n)\ [log\theta + C]$$

$$= \frac{1}{n}\left[log\frac{b}{s-b} + C\right]$$

when $\phi = O$, $b = B$ and $\phi = \frac{1}{n} log\frac{b.(s-B)}{B.(s-b)}$

whence $b = sBe^{\phi n}/A + B^{\phi n}$

Alternatively, using the method of Section I

$$da/d\phi = -s/(1+n\theta)^2$$

$$\phi = \int (s-b)\ (1+n\theta)^2/bns$$

$$= (s/n)\int 1/b(s-b).db$$

$$= (1/n)log(b/s-b) \text{ as before.}$$

If n = 1, $a = s/(1+\theta)$

$$b = sBe^{\phi}/(A+B^{\phi})$$

In this case if the velocity of the driver is constant the acceleration of the follower is constant. Therefore if the follower is associated with a fixed mass or moment of inertia a constant torque on the driver will give a constant force and acceleration to the follower.

Example 2.—

$$V = me^{n\theta}$$

by similar methods

$$\phi = (s/n)(1/B - 1/b)$$

and $b = Bs/(s - B\phi n)$

Example 3.—

$$V = n/\theta$$

$$a = s/(1+n/\theta)$$

$$\phi = (1/n)\int \theta d\theta$$

$$= (1/2n)[\theta^2 + C]$$

when $\theta = O$, $b = B$

and $\phi = (s/2n)[(s-2b)/b^2 - (s-2B)/B^2]$

In this case the values of b must be determined for corresponding values of ϕ by plotting, by interpolation or by solving quadratics for b after substituting values of s, n and B.

Example 4.—

$$V = \sin\theta$$
$$a = s/(1+\sin\theta)$$
$$\phi = \int \operatorname{cosec}\theta . d\theta$$
$$= \tfrac{1}{2} \log \frac{1-\cos\theta}{1+\cos\theta}$$
$$\epsilon^{\phi} = \log \frac{\sqrt{s}-\sqrt{s-2b}}{\sqrt{s}+\sqrt{s-2b}}$$
$$(\epsilon^{\phi}+1)/(\epsilon^{\phi}-1) = \sqrt{(s-2b)/s}$$
$$\text{whence } b = -2s\,\epsilon^{\phi}/(\epsilon^{\phi}-1)^2$$

Alternatively, using the method of the previous section,

$$da/d\theta = -s\cos\theta/(1+\sin\theta)^2$$

which after substituting b/a for $\sin\theta$ and $\sqrt{a^2-b^2}/\theta$ for $\cos\theta$ eventually gives the same result for ϕ and b. Similar calculations give the following results for the trigonometric functions.

V	ϕ	b
$\sin\theta$	$\log \frac{\sqrt{s}-\sqrt{s-2b}}{\sqrt{s}+\sqrt{s+2b}}$	$-2s\epsilon^{\phi}/(\epsilon^{\phi}-1)^2$
$\cos\theta$	$\log \frac{\sqrt{s}+\sqrt{s-2b}}{\sqrt{s}-\sqrt{s-2b}}$	$2s\epsilon^{\phi}/(\epsilon^{\phi}+1)^2$
$\tan\theta$	$\log \frac{b}{\sqrt{s^2-2sb+2b^2}}$	——
$\sec\theta$	$\sqrt{s(2b-s)/b}$	$s[1\pm\sqrt{1-\phi^2}]/\phi^2$
$\operatorname{cosec}\theta$	$-\sqrt{s(2b-s)/b}$	$s[1\pm\sqrt{1-\phi^2}]/\phi^2$
$\cot\theta$	$-\log b/\sqrt{s(s-2b)}$	——

In all cases $a = s/(1+V)$

Example 5.—The method will be used for a given form of driver, using the same example as in section 1.

$$a = A\epsilon^{n\theta}$$
$$V = b/a = (s-a)/a$$
$$= (s - A\epsilon^{n\theta})/A\epsilon^{n\theta}$$
$$\phi = \int \frac{Ae^{n\theta}}{s - Ae^{n\theta}} d\theta$$
$$= -(1/n)[\log (s - Ac^{n\theta}) + C]$$
$$= -(1/n)[\log b + C]$$

when $\phi = O$, $b = B$ and $C = -\log B$

$$\therefore \phi = -(1/n)\log(b/B)$$

as previously,

$$\text{and } b = B\epsilon^{-\phi n}$$

(b) Graphical construction

In this case V and 1/V are plotted against θ as shown in Fig. 3. 1/V is then integrated in steps of say 5° of θ to give ϕ which is plotted on the same co-ordinates as shown.

Then since $V = b/a = (s-a)/a$ or $b/(s-b)$

it may be deduced $a = s/(1+V)$ and $b = s/(1+1/V)$

Thus the first formula may be used to calculate the polar co-ordinates for the driver and the second formula to calculate the co-ordinates for the follower by reading off corresponding values as shown in the figure.

This principle may also be used to design the follower from the driver. In this case a is plotted against θ and b is indicated as the difference between b and s. The quotient a/b is then plotted to give $1/V$ which is then integrated in steps as before to give the co-ordinates of the follower.

III. To design the driver and follower to a particular displacement function

(a) Theoretical calculation

In this case let $\phi = F(\theta)$ and conversely $\theta = f(\phi)$.

then $V = d\theta/d\phi = 1/F'(\theta)$ and $1/V = f'1/(\theta)$

and $a = s/[1+1/F'(\theta)]$ and $b = s/[1+1/f'(\theta)]$

Example 1.—

$\phi = \theta^n$	$\theta = \phi^{1/n}$
$d\phi/d\theta = n\theta^{n-1}$	$d\theta/d\phi = (1/n)\phi^{-1+1/n}$
$V = (1/n)\theta^{1-n}$	$V = n\phi^{n/1-n}$
$a = s/[1+(1/n)\theta^{1-n}]$	$b = s/[1+n\phi^{n/(1-n)}]$

Example 2.—

$\phi = \log\theta$	$\theta = \epsilon^{\phi}$
$d\phi/d\theta = 1/\theta$	$d\theta/d\phi = \epsilon^{\phi}$
$a = s/(1+\theta)$	$b = s/(1+\epsilon^{-\theta})$

Example 3.—

Similarly $\phi = \sin\theta$ $a = s/(1+\sec\theta)$ $b = s/(1+\sqrt{1-\phi^2})$

$\phi = \cos\theta$ $a = s/(1-\operatorname{cosec}\theta)$ $b = s/(1-\sqrt{1-\phi^2})$

$\phi = \tan\theta$ $a = s/(1+\cos^2\theta)$ $b = s/2+\phi^2$

It will be appreciated that in this case the functions are reversible and also the follower may be calculated from the velocity ratio or polar co-ordinates of the driver and vice versa. Usually this entails a lot more calculation but may sometimes be used as check or tried if an inverse function presents a difficult integration.

At this stage it may be pointed out that reversibility does not apply to previous sections. Non-realisation of this may introduce errors. It will also be realized that in previous cases the dimensions of the driver are given; if those of the follower are given (or the velocity ratio referred thereto) the follower must be regarded as the driver and vice versa.

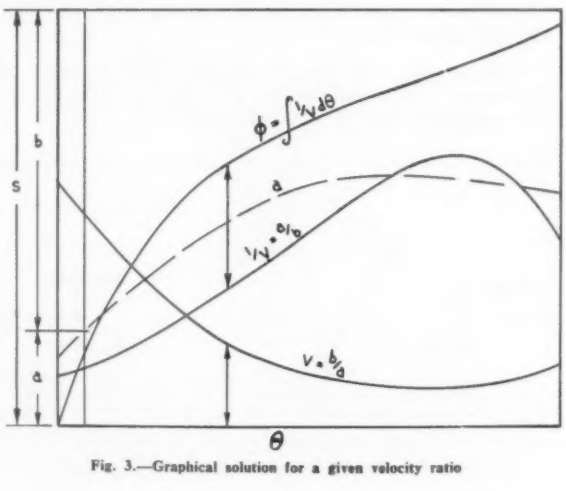


Fig. 3.—Graphical solution for a given velocity ratio

(*b*) *Graphical construction*

In this case ϕ is plotted against θ as shown in Fig. 4. A series of values of θ is taken and the slope of the graph measured in each position.

Then since $V = d\theta/d\phi = \text{Cot}\gamma$ and $1/V = \text{Tan}\gamma$

Direct readings of these values may be obtained by using the scales against unity as shown in the corners of the figure.

For the driver $a = s/(1+Cot\gamma)$ for corresponding values of θ, and for the follower $b = s/(1+tan\gamma)$ for corresponding values of ϕ.

Geometry

In designing a pair of gears, if there is no continuous rotation, the follower should be slightly longer than the driver. It is usually advantageous to approximate the curves by a series of circular arcs, and constructing tangents and normals at salient points may assist this. The most satisfactory arrangement is with the arcs meeting on the true curve and this is arranged by constructing a series of isoscelese triangles with their sides touching and their base angles touching the curve, the apexes forming the centres of the arcs. If possible the vertical angles should be equal but otherwise the radii of the arcs should be arranged in geometric progression.

Drawing in circles of curvature may also assist and the following are standard formulae for polar co-ordinates.

Length of curve $S = \int \sqrt{r^2+(dr/d\theta)^2}\,.\,d\theta$

Radius of curvature $\rho = \dfrac{[r^2+(dr/d\theta^2)]^{3/2}}{r^2+2(dr/d\theta)^2-r(d^2r/d\theta)^2}$

Example.—For the logarithmic gear

$$r = A\epsilon^{n\theta} \text{ where } n = tana$$

$$dr/d\theta = nA\epsilon^{n\theta} \quad d^2r/d\theta^2 = n^2A\epsilon^{n\theta}$$

$$S = \int \sqrt{r^2+n^2A^2\epsilon^{2n\theta}}$$

$$= sec\,a.A\int \epsilon^{n\theta}.d\theta$$

$$= cosec\,a.A[\epsilon^{n\theta}+C]$$

$\theta = O$, $S = O$ and $C = -1$

$$S = A\ cosec\ a[\epsilon^{n\theta}-1]$$

$$= A\ cosec\ a[(r/A)-1]$$

$$= (r-A)cosec\ a \text{ or } \partial\ cosec\ a$$

$$\rho = [(r^2+r^2n^2)^{3/2}] \div [r^2+2r^2n^2-r^2n^2]$$

$$= r^2sec^2a/r^2sec^2a = r\ seca$$

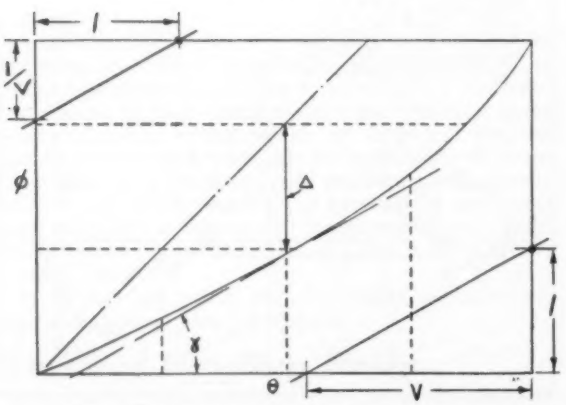


Fig. 4.—Graphical solution for a given displacement function

Thus the increase in area may be regarded as a curved triangle of angle a and the centre of curvature of any point is on a perpendicular to the radius through the origin (see Fig. 7).

It will be appreciated at this point that internal gears may be designed, giving rotation in the same direction, but the members cannot be identical.

Non-circular gears

In designing a pair of gears, the following general principles should be observed:

(1) As mentioned at the beginning, the point of contact of the gears must always be in line with their centres of rotation.

(2) For continuous rotation there must be an integral (or integral fraction) velocity ratio. For example, a rounded square and rounded triangle would give a mean velocity ratio of 3/4. Identical gears give a mean velocity ratio of 1/1, are interchangeable and have lower production costs.

(3) If possible, one of the gears should be a recognized form, e.g., eccentric circle, ellipse or spiral. The latter two may be identical pairs as will be explained later.

(4) The angle of obliquity of the common tangent at the pitch point must be low enough to avoid "pull-out". Theoretically this must be less than the complement of the pressure angle of the teeth used—in practice much less. Conversely, for rolling curves a large angle is desirable to give a positive action and avoid large separating forces or toggle action between the centres of rotation. In some cases it may be advantageous to change over from gears to rolling curves or vice-versa as the angle of obliquity reaches about 45°, but it will be realized that rolling curves are not reversible in action unless loaded or connected by springs or links. If possible gears should be mounted in a horizontal plane.

Eccentric gears

Fig. 5 shows an eccentric gear in mesh with an approximately quadrantal rack. This was an old application in

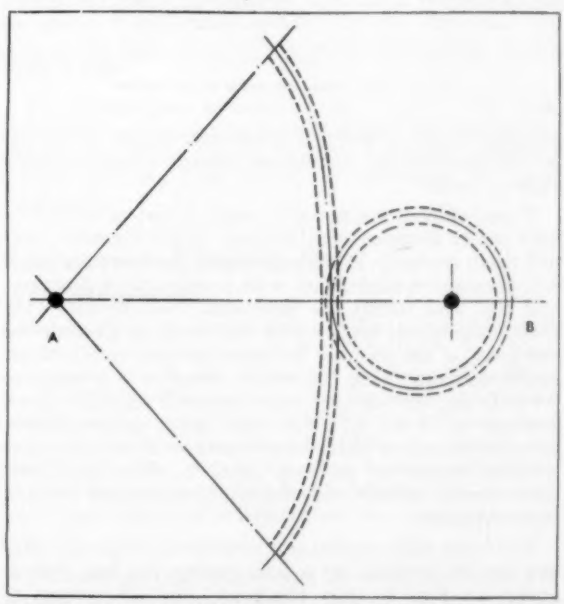


Fig. 5.—Eccentric gear in mesh with an approximately quadrantal rack. A, quadrant; B, eccentric circle

the steering gear of ships to give greater mechanical advantage as the rudder moves from neutral position and experiences greater water pressure. In this case a standard circular gear is generated on a blank with eccentric boss and a rack designed and cut to suit as explained in section I. Theoretically, if the "rack" were a rounded square, continuous rotation would be obtained. It should be realized however that whichever way the quadrant is fitted to the rudder post, the water pressure will tend to pull the gears out of mesh and they must therefore be designed accordingly.

Elliptical gears

These gears have the advantage that they may be made identical, give continuous rotation and have a symmetrical velocity ratio curve. A modern application is in the actuation of servo tabs in aircraft control surfaces, where, conversely, to that of ships, the function is to give greater velocity ratio in manoevres. In this case there is not continuous rotation but full use is made of the peripheries. The symmetrical velocity ratio curve gives equal effect in both directions of movement, which is not obtainable by linkwork. Elliptical gears have also been used in quick return motions as in

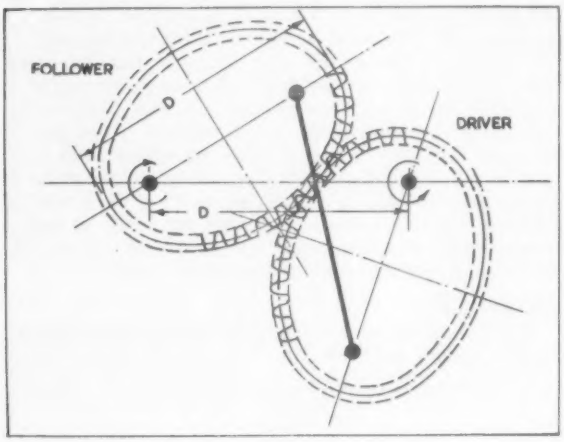


Fig. 6.—Link joining free foci to prevent pull-out

planing machines where a lower mechanical advantage is sufficient during the return stroke, giving a higher velocity ratio.

If two ellipses are mounted each at one of their foci with centre distance equal to their major diameter, they will mesh perfectly for as one radius increases the other will decrease in accordance with a well-known principle, and this also fulfills the geometric theorem that both radii make equal angles with the tangent. Considering one gear, if the distance between the foci is 1/3 of the major diameter, then the minor diameter d is equal to 0·943 D and the velocity ratio changes from 1/2 to 2, an increase of 1 to 4. Thus with gears approximately circular there is a fairly large increase in velocity ratio without danger of pull-out. Since at first sight these gears appear circular, they are often erroneously referred to as eccentric.

If ellipses with greater eccentricity are required, pull-out can be avoided by a link joining the free foci as shown in Fig. 6, thus combining the advantages of linkwork and elliptical gearing. Actually continuous rotation could be obtained in one direction without the use of links by using teeth on one half of each ellipse as actually drawn in Fig. 6 but extended a few teeth beyond the dead centres, the rest being smooth curves along the pitch lines. For reversible action and using links, teeth are only necessary for a short distance at each dead centre.

Hyperbolic gears may be designed, one rotating about the internal and the other about the external focus. Similarly, parabolic gears may also be designed, one rotating about the focus and the other moving laterally, i.e. about a point at infinite distance. These gears would be identical pairs but one could be altered to suit a modified centre distance.

Logarithmic gears

These are shown in Fig. 7 but might be called more appropriately "exponential gears". They have the advantage that they are of recognized form and may be made identical. They give an increasing or decreasing velocity ratio but are not normally suited for continuous rotation. The latter may be arranged however by using in effect two half gears on the same blank but there will be a discontinuity at "change over". They have the advantage that the angle of obliquity is constant, tending to give a smooth action. If radii are considered at equal angles to each other, they will form similar triangles at the pitch line. For right angled triangles of centre angle β, $(1/\beta)\log\cos\beta = \tan\alpha$. These triangles are shown in Fig. 7, but an auxilliary construction may be used as shown in Fig. 7a. If the centre distance S is not important, the angle β may be, say, 30° and right angled triangles used on a value of B, or conversely B adjusted to a given value of S.

It should be clearly understood that these gears do not give a logarithmic or exponential velocity ratio or displacement. For a particular velocity ratio the gears may be modified but the members will not be identical and the obliquity will vary.

Displacement gears

Section III, Example 2, gives the calculations for obtaining a velocity ratio log θ and the converse. Fig. 8 shows diagrammatically how these functions may be added by differential gears and then resolved back again to give the product of the two original functions.

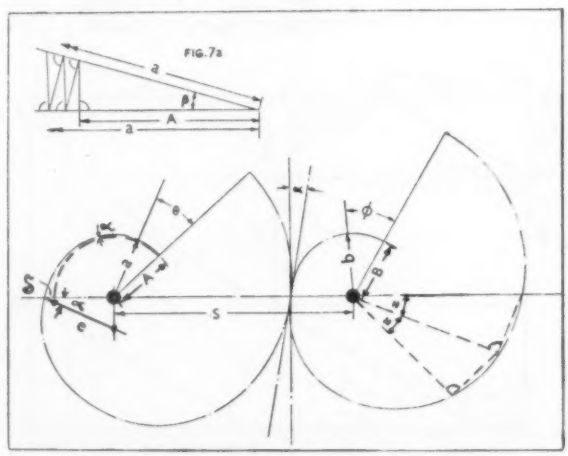


Fig. 7.—Logarithmic or exponential gears. Fig. 7a, graphical construction

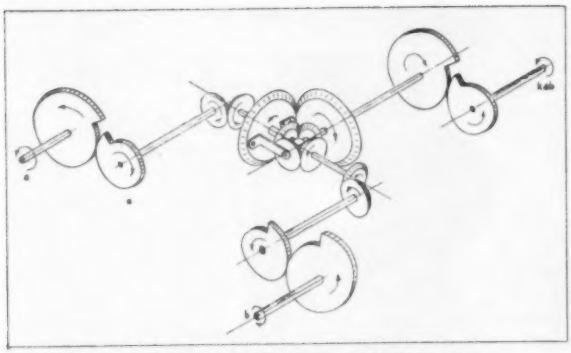


Fig. 8.—Addition and resolution of functions by differential gears

By rearranging the differential, the quotient may be obtained and extra gears and differentials may be used to give the product and/or quotient of more than two functions.

This principle may also be used to obtain the product of other functions, e.g. a sin θ. The gears are generated for log a and log sin θ and the product obtained by a gear for log b as previously.

Rack gears

It may be required to design a non-circular rolling curve or gear to mesh with a curve or rack moving in a linear direction as on the table of a planing machine or similar mechanism. In this case the radius of the latter is regarded as infinite and in general the methods already given apply.

Gear generation

In the layout of non-circular gears it is generally preferable to treat the pitch lines as a series of circular arcs as explained previously. In the case of elliptical gears, four arcs are satisfactory for the example given in the text, but for greater eccentricities eight arcs may be preferable.

Although theoretically each tooth flank should be generated on a base circle corresponding to its own radius, in practice it is more satisfactory if base circles corresponding to each circular arc are used. Eccentric circular gears may be cut as for ordinary circular gears. For others a D.P. may be chosen as for a circular gear of approximately equal size, the number of teeth deduced for the actual periphery and adjusted to an integral number. Then the pitch can be re-calculated.

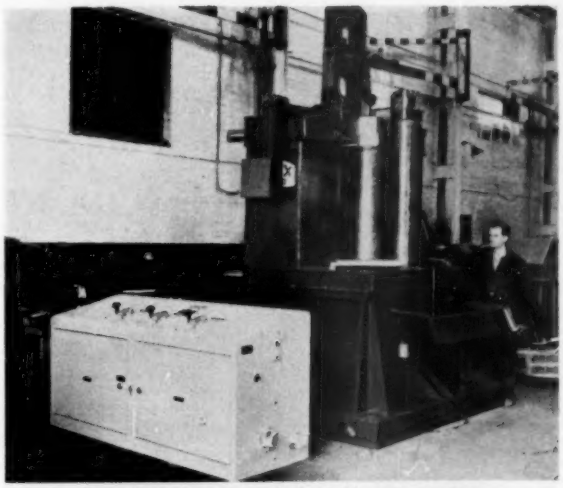
Conclusion

The foregoing contains calculations which have been simplified as much as possible to enable a quick grasp of the fundamental principles to be obtained. Formulae are derived in each specified case and examples given where relatively simple results are obtained, but this should not preclude their use for more difficult cases. Very often both theoretical and graphical methods may be used, not only as a check, but also because the former may show the advantage of recognized forms, whilst the latter may show the effect of using adjustments to simplify the result.

It is therefore hoped that the results indicated will enable designers to use these gears.

Vertical Bending Rolls

An exceedingly strong and robustly constructed machine to withstand arduous shipyard working conditions has been produced by The Bronx Engineering Company Limited, Lye, Nr. Stourbridge. It is a 4-roll initial pinch type plate bending rolls which will deal with mild steel plate from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in. thick and up to 36 in. wide at a speed of 18 ft per min.



Four-roll initial pinch type rolls for dealing with ship plates

Special attention has been paid to the design of the vertical roll neck bearings which incorporate anti-friction thrust bearings fitted on all rolls to take vertical loads in both directions. The two centre pinch rolls are positively driven and the two side bending rolls are idle. Limit switches are fitted to control the travel of the side bending rolls, thus preventing accidental overload. A swing down end bearing is provided, fully balanced, to allow cylindrical work to be easily withdrawn from the rolls.

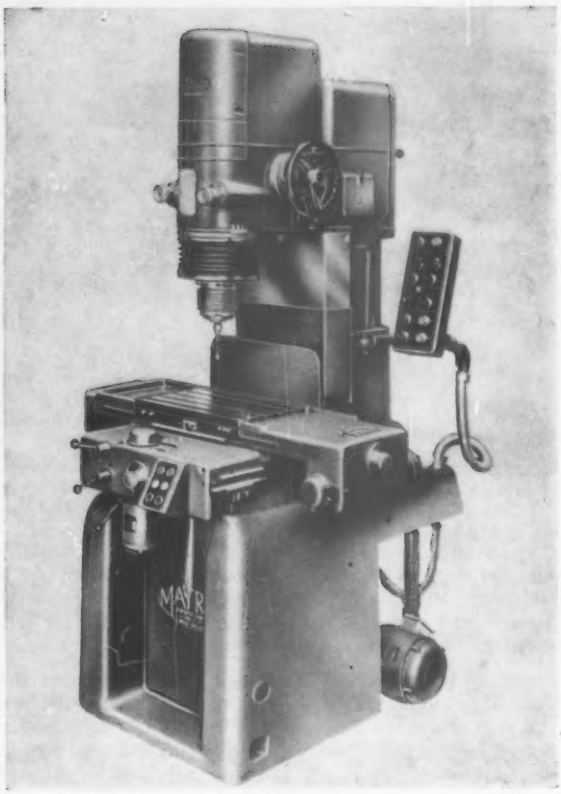
Adequate precaution is provided to prevent scale from fouling the main drive pinions and chock slideways and horizontal rollers are mounted on the baseplate to prevent the plate from falling below the bottom of the vertical rolls.

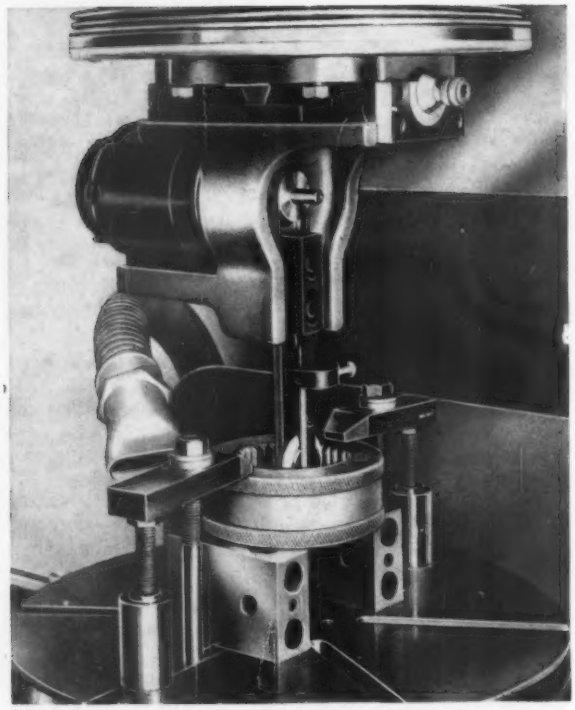
The control gear is mounted in a multi-motor desk type panel with separate contactor gear to operate the 30 hp main drive motor, 2–25 hp side roll adjusting motors and the 5 hp motor for operating the back pinch roll.

Lacquer Finish for Aluminium

A tough, highly decorative range of Epoxy based lacquer finishes for aluminium called "Lakadize", has been introduced by Swale Chemicals Limited, Woodham Road, Aycliffe, Darlington, Co. Durham. No special equipment is required beyond ordinary paint shop plant and Lakadized articles may be blanked, formed and pierced after the coating has been applied and baked. The finishes are permanent when subjected to ordinary wear; have high scuff resistance and the colours are light fast.

The coating is transparent and the surface to which it is applied must be clean and uniform in appearance. Stoving is for 20 min at 170° C.





Grinding an internal spline on the new matrix jig grinder. The machine is free from vibration and fully protected. Speedy power controls followed by fine hand adjustments enable quick setting to 0·0001 in.

New Matrix Jig Grinder Works Hardened Material Without Distortion

With the new "Matrix" 56-12-18 jig grinding machine, hardened materials can be worked without distortion and held to close tolerances, thus overcoming the problems of maintaining tolerances when hardening finished parts.

The spindle head unit is totally enclosed and fully protected against the ingress of dust and dirt. Every precaution has been taken to eliminate sources of vibration and special materials have been utilized to ensure dimensional stability at varying temperatures. The head has a maximum traverse of 16 in. and is carried on a vertical slide running in generously constructed ways extending the full depth of the machine. Vertical movement is powered by an independent motor controlled by push buttons on the apron. A scale indicates the head position and limit switches prevent overrun.

The high frequency spindle has four speeds from 12,000 to 50,000 rpm. An important feature is its ability to maintain a constant speed irrespective of load, enabling a preset speed to be selected and repeated at any time. The spindle is mounted on a cross slide with a travel of 1½ in. which is controlled by a head mounted dial graduated in 0·0001 in. divisions for imparting radial feed whilst grinding. The collet nose permits the use of diamond impregnated stalks or grinding spindle quills. The maximum diameter of hole ground is 5 in. but a special adaptor plate available as optional equipment increases the capacity to 9 in. dia.

A variable speed motor provides infinitely variable quill speeds of 25 to 255 rpm. Vertical travel is power or hand operated to suit the work being undertaken and the power traverse speed is infinitely variable between 10½ and 105 in./min. The quill can be traversed to the top of its maximum stroke of 4 in. without disturbing the setting of the traverse stops, enabling gauging and inspection to be carried out with the minimum loss of production time.

The quill can be rotated by hand for segmental grinding through a predetermined arc, a graduated control dial enabling this operation to be performed with a high degree of accuracy. Another feature is the inclination of the quill up to an angle of 1½° giving accurate control for parallelism and facilitating grinding tapers up to 3° included angle.

The table working surface measures 18 in. × 12 in., longitudinal and cross traverses being 12 in. and 8 in. respectively. Movements are by hardened thread ground leadscrews of special wear resisting steel and a corrector bar system ensures precision settings. Each movement is separately operated by its own motor at a traverse rate of 32 in./min and controlled by push buttons on the apron. An overload clutch prevents any possible damage to the leadscrews and an automatic brake prevents overrun.

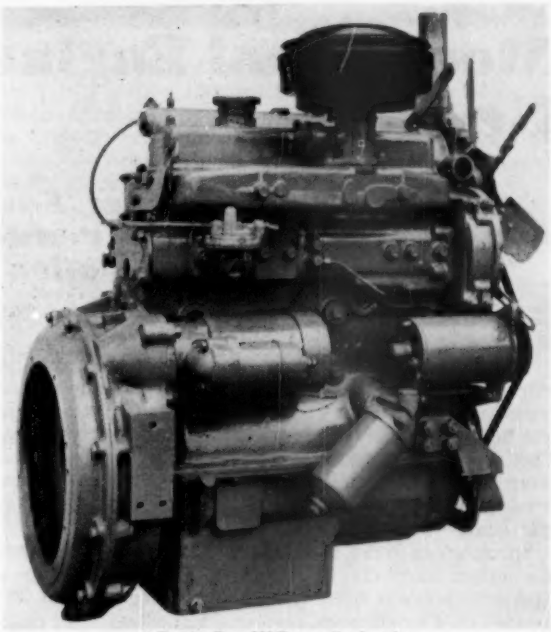
Setting is a quick and simple operation as the approximate position is reached by power traverse and the final setting made by hand controls reading to 0·0001 in. direct by vernier. These dials are mounted below the table surface adjacent to the controls and protected by armour plate glass.

Among the extra equipment available is a spline and slot grinding attachment powered by a $\frac{1}{16}$ hp motor providing wheel speeds of 13,000 and 20,000 rpm. Wheels from $\frac{7}{8}$ in. to $1\frac{1}{2}$ in. dia can be used. Micrometer adjusted compound slides with verniers reading to 0·0001 in. enable adjustments and corrections to be made without moving the compound table of the machine or disturbing the co-axial setting of the circular table in relation to the quill.

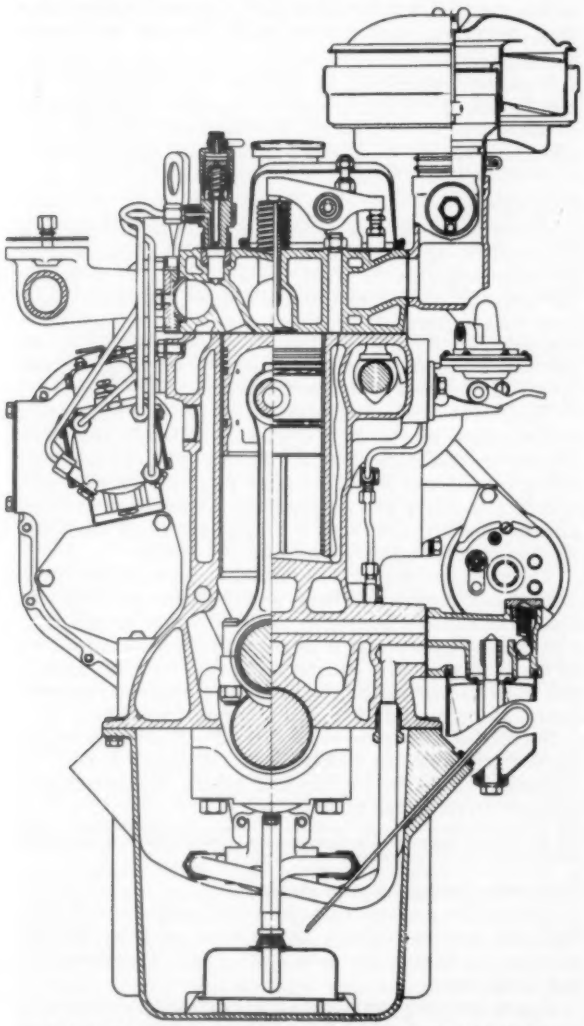
This, the only British designed and built jig grinding machine, is a product of the Coventry Gauge & Tool Company Limited, who have had wide experience in the manufacture of jig boring and precision grinding machines. Sole selling agents in the United Kingdom are The Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2.

New 60 Bhp Industrial Diesel

A new 60 bhp industrial diesel engine for industrial application which embodies a number of longer-life features is announced by Perkins Engines Limited, of Peterborough. It is the "Four-203", a numbering which follows the current Perkins practice of indicating by the engine's name the number of cylinders and cubic inch capacity.



A Perkins Four 203(I) type diesel engine



Sectionalized transverse view of a Perkins Four 203 industrial diesel engine

For variable speed applications such as fork lift trucks and mobile cranes, requiring between 2,000 and 2,400 rpm, the engine is available with a hydraulic governor, and is rated up to 60 bhp at 2,400 rpm. Offering high power-weight ratio, the Four-203 develops up to 47 bhp at 2,000 rpm for continuous use when fitted with a mechanical governor. Maximum torque at 1,350 rpm is 151 lb/ft.

The engine is of 3·6 bore, 5 in. stroke and 203·5 cu in. capacity. Perkins are also offering another almost identical version, named the Four-192, which has a smaller 3·5 in. bore, develops 45 bhp at 2,000 rpm continuous rating and 58 bhp at 2,400 rpm for intermittent use. A feature is the practical method of meeting power take-off requirements. Timing is by a geared drive, which gives improved running and allows power take-off from the gearing at two points. Facilities are available for driving a hydraulic pump off the camshaft gear with a capacity of up to 17 gpm at 1700 psi, to operate main hydraulics such as fork lift truck equipment. Provision is made also for a hydraulic pump beneath the fuel pump, a point particularly suitable for connecting power-assisted steering systems.

Anti-vibration Nut

A new all-metal Potentiometer anti-vibration nut is announced by Simmonds Aerocessories Limited, of Treforest, Glamorgan. It is made of aluminium alloy B.S. 1476 H.E. 10, with internal threads $\frac{3}{8}$ in. × 32 T.P.I. and external threads $\frac{5}{8}$ in. × 28 T.P.I. It has a spring steel, cadmium plated locking insert which gives a highly consistent performance over much wider spindle tolerances than the existing Nyloc version, which it is intended to supersede.

Mechanical Engineering Research

Work at East Kilbride on metal extrusion, noise reduction in pipes and steam condensation

Extrusion of aluminium and aluminium alloys

The lowest temperature at which a product can be extruded may be determined solely by the available press-capacity. On the other hand, if the temperature is too high, undesirable metallurgical changes may occur. This upper temperature limit depends on both the temperature of the billet and on the heating-up of the product caused by conversion of the work of deformation into heat.

Specimens of 99·5% pure aluminium and a high-strength aluminium alloy (DTD 363) have been extruded in a hydraulic press at billet temperatures ranging from 20° to 450° C. The effect of ram speed and extrusion ratio (the ratio of the cross-sectional area of the billet to that of the product) on the extrusion pressure and temperature rise in the product has been studied.

The temperature rise resulting from the work of deformation can be quite large. For example, at an extrusion ratio of 200 and a billet temperature of 300° C, there is a temperature rise with aluminium of 170° C at a ram speed of 30 in. per min. For comparable extrusion conditions the temperature rise in the alloy is greater than in the pure metal.

Hot shortness (cracking of the surface of the product) occurred in the alloy under various combinations of billet temperature, extrusion ratio, and ram speed. This failure took place when the temperature of the product reached about 480° C. If this alloy is extruded at the usual billet temperature of 400° C, ram speeds must be kept low to prevent the onset of hot shortness.

For extrusion ratios greater than four, it was found that there is a linear relation between the extrusion pressure and the logarithm of the extrusion ratio. There is also a linear relation between extrusion pressure and billet temperature.

Preliminary investigations of the effects of extrusion conditions on the hardness, tensile strength, and dimensional accuracy of the product have also been made.

NEL Plasticity Report No. 146 (Extrusion of metals. Part 7—Pure aluminium and aluminium alloy D.T.D. 363, by K. Ashcroft and G. S. Lawson).

Noise reduction in oil pipes

The liquid-borne noise transmitted through an oil pipe can be greatly reduced by fitting a silencing chamber containing a suitable arrangement of sound-absorbing material. The relative effectiveness of eight arrangements of baffles and different materials has been measured over a frequency range from 2 to 20 kc/s. The tests were made in a 4-in. dia pipe fitted with a 10-in. dia silencing chamber (about 30 in. long).

A reduction in noise intensity of up to nearly 100:1 (40 decibels) was obtained with a 2-in. thick lining of a cellular plastic in the silencing chamber, parallel to the direction of flow, fixed between perforated baffles. This material is effective only when the pores are full of air—it can readily be sealed from oil by enclosing it in thin polythene sheeting. A screen of air bubbles was as effective as the cellular plastic lining but this would not be suitable for many practical applications.

Reductions in noise of about 10:1 (20 decibels) were obtained with other absorbent linings and absorbent screens. They included linings of a polystyrene insulating material which is impervious to oil penetration; screens of this material or the cellular plastic, perpendicular to the flow direction; and rubber balls between perforated screens.

It is also important to prevent the transmission of noise and vibration through the pipe walls. Special precautions were taken in these tests to prevent this.

MERL Fluids Note No. 72 (Noise reduction in an oil piping system, by I. S. Pearsall and J. Kane) available from the Laboratory.

Cold extrusion

The maximum extrusion pressure can be greatly reduced by pre-forming a cone on the head of the billet. With a 60° cone-angle on the billet and a 60° conical die-entry, the pressure needed to extrude copper rod is 28% less than that required to extrude a normal cylindrical billet through the same die. This technique is likely to be particularly useful in the production of extruded products which are normally outside the capacity of a press.

This is one of the conclusions from the first stage of an investigation of the cold extrusion of steels and non-ferrous metals under impact conditions. The work is being carried out to see in what ways the varying ram speed of a crank press affects the extruded product, in comparison with extrusion in a hydraulic press where the ram speed is constant throughout its stroke.

The pressures required to produce a given reduction in aluminium, copper and brass were found to be similar to those needed in a hydraulic press at slower speeds. The extrusion pressure was related linearly to the logarithm of the extrusion ratio (the ratio of cross-sectional area of the billet to that of the product) for aluminium, copper, brass, niobium, titanium, and a range of steels.

Successful extrusions were carried out at large reductions from unheated billets—in most cases the limit of reduction seems to be imposed by the maximum permissible stress in the punch.

MERL Plasticity Report No. 138 (Cold extrusion of metals. Part 6—Under impact conditions, by M. T. Watkins and J. McKenzie).

Drop-wise condensation of steam

It might be possible to build steam condensers of only half the present-day size if the rates of heat transfer obtained in laboratory-scale tests could be achieved in full-scale plant.

Steam normally condenses on the cooling surface as a more-or-less continuous film of water, which slows down

the rate of heat flow. If the cooling surfaces are treated with special water-repellent chemicals (known as promoters) the steam may condense as separate droplets and a much greater rate of heat transfer is obtained. About 70 promoters have been produced for the laboratory; they are suitable for copper, brass and cupronickel cooling surfaces. Under laboratory conditions they remain effective for up to several thousand hours.

Further laboratory trials are in progress to see how different promoters react to various steam conditions when applied to a range of copper-alloy tubes. A special condensing unit is being built so that the effect of promoters on the overall efficiency of a condenser can be measured.

The way that these promoters stand up to practical working conditions has been studied by treating condenser tubes in a cross-channel steamer and in a power station. The steamer tests were successful but in some of the power-station tests the promoter became ineffective when deposits formed on the treated surfaces. The laboratory would be pleased to collaborate with other industrial organizations in trying out the compounds under practical conditions.

The promoters have been patented. The patent rights are held by the National Research Development Corporation, 1 Tilney Street, London W1.

Fitness, A.D. Improved efficiencies in copper-base heat exchangers. *Copper*, 1959 (5), 2–5. Reprints (ref. 3/6) are available from the Laboratory. Blackman, L.C.F. Dropwise condensation of steam. *Research, Lond.*, 1958, **11** (10), 394–400.
The various reprints mentioned above are available from the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

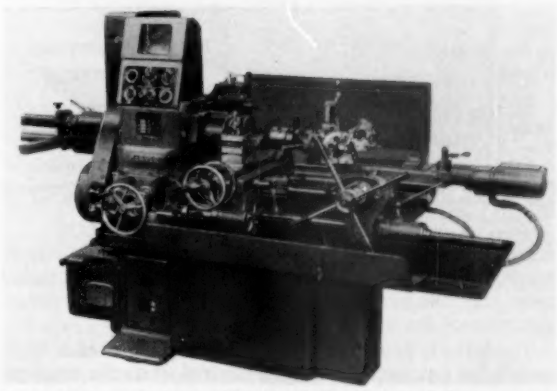
Speed and Accuracy in Machining

Illustration of modern machine tool performance

THE demonstration of a number of modern machine tools recently provided a useful opportunity for appreciating some of the finer points of design and performance. The event took place at the London showrooms of Alfred Herbert Limited, of Coventry, where were gathered the group of machines which had earlier been on show in Paris. Some of the machines are described below: it will be noticed in particular how, in catering for very high production rates with great accuracy, dependence upon repetitive physical movement by the operator has been largely removed from the time element.

The Herbert No. 2D capstan lathe is one of the smaller machines of the Herbert range and accommodates bar work up to 1½ in. dia or chuck work up to 9 in. swing. It has a range of eight reversible spindle speeds from 160–2550 rpm and reversible pick-off gears provide a further eight speeds from 50–810 rpm. The machine can be fitted with the Herbert programme control system which automatically selects speed changes and starts, reverses and stops the spindle, as required, when the turret is indexed. This system reduces setting-up times, operational fatigue and also non-cutting times, but the fundamental advantage is to ensure that the operator uses the correct speed for the particular operation. In effect, this progress in design is not solely to eliminate the human element but to ensure greater efficiency from unskilled labour, i.e., better quality work and longer runs between regrinding of the tools.

The system is basically a punched board panel and limit switches. Plugs inserted in the appropriate holes in the panel select the required forward or reverse rotation of the spindle, spindle speed and spindle start and stop, also a change of spindle rotation. The latter change would be required for withdrawal of a tap or for such operations from the rear toolpost as parting-off with a Chipstream parting-off tool. Automatic selection is actuated by the modified "barrel-type stops" fitted to the end of the capstan slide contacting the limit switches. Thus, indexing of the turret at the end of the reverse traverse of the capstan slide automatically selects the pre-set conditions for machining from the next turret face. Change of spindle direction, however, after a tapping operation, is automatically effected at the end of the forward stroke of the capstan slide.

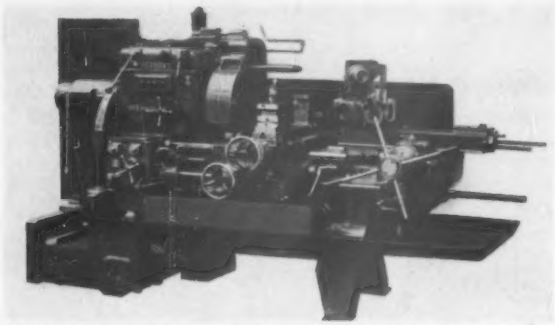


A programme control system which automatically selects speed changes, reverses and stops the spindle as required, can be used with the Herbert No. 2D capstan lathe

In the punched plug board panel there are twelve vertical columns of holes; a pair of holes to each face, one to six, of the turret. Under each turret face on the panel the top two horizontal rows of holes, according to the positioning of the two-pin plug, determine the direction of spindle rotation. A plug in row A, B, C or D determines which of the speeds of the four-speed pole-changing motor is required. A plug in either the yellow or blue panelled row of holes will select either the fast or slow clutch relative to each speed of the motor; any one of eight speeds can be selected for each turret face. A two-pin plug is also inserted in the lower two rows of holes in the board for either changing the spindle direction or stopping the spindle.

There is a limit switch to each face of the hexagon turret which, when contacted, selects the appropriate vertical row of plugs on the board, thus controlling direction of rotation of the spindle, motor speed and through magnetic clutches in the two-speed driving box, the spindle speed. The change of spindle rotation at the end of the cut is obtained by the stop bar contacting the

Specially designed for the high rate production of non-ferrous threaded parts requiring frequent spindle reversals, the Herbert No. 2 Flashcap lathe has twelve spindle speeds



The transverse and longitudinal feeds of the Herbert No. 5 Senior Preoptive capstan lathe are controlled by a single lever. The machine takes bar up to 2½ in. dia and chuck work up to 15½ in. dia

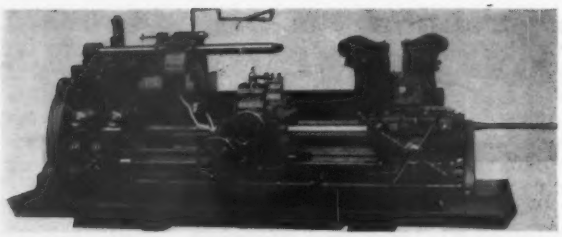
dead stop and actuating a limit switch through a lever arrangement. A pre-punched card can be superimposed over the machine plug panel to ensure the correct insertion of the plugs.

The lathe is provided with a control panel which has a switch for automatic- or hand-control, thus the machine can be used as a conventional type of capstan lathe.

A weight-operated bar feeding arrangement with mechanism for automatic opening and closing of an air-operated dead-length bar chuck known as the Autobar chuck can be fitted to the machine. The operating unit consists of a combined operating lever and dead stop mounted on one face of the turret. During the forward movement of the turret the chuck is opened, the bar feeds out to the dead stop, and, when the required pre-set length is obtained, the chuck closes automatically. The chuck remains open unless the feeding of the bar is to the correct length.

The Herbert No. 2 Flashcap lathe has been specially designed for the high rate production of non-ferrous threaded parts requiring frequent spindle reversals. Twelve spindle speeds from 158–2660 rpm through pick-off gears and two spindle speeds in any one set-up are available. Forward and reverse to the spindle is automatically operated by movement of the capstan slide.

The machine is equipped with the new Herbert No. 2 Quadra-chuck which is an air-operated indexing 2-jaw chuck to reduce chucking times when machining multiple-end components such as elbows, tees and crosses. Only one chucking is necessary to machine all ends whether of similar or different size or form, and machining can be continuous without stopping the spindle. Since the



Profiles on components are reproduced from master templates by this Herbert No. 9C combination turret lathe. The machine is fitted with a hydraulic copying attachment

Quadra-chuck can be indexed faster than the hexagon turret and whilst the spindle is running, it is possible to perform the same operation on all ends of the component, providing they are of similar size and form, between indexing of the turret.

Closing of the chuck jaws is by a lever on the headstock which controls the piston of a revolving air cylinder at the rear of the spindle and, through a draw-tube and levers, actuates the self-contained hydraulic system in the body of the chuck. The chuck jaws are mounted on the ends of hydraulic cylinder pistons which permit their rotation, in addition to end movement for gripping. A foot pedal controls the chuck indexing.

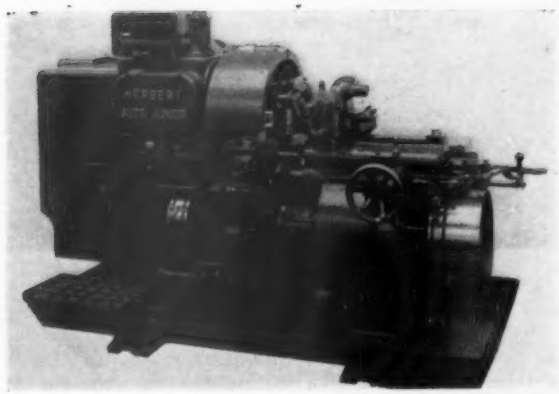
The chuck will accommodate work which can be indexed in a radius of 2½ in., maximum distances between the location faces of the jaws is 2⅛ in., minimum ⅞ in., thus the maximum stroke of each jaw is ⅜ in. The maximum diameter of work which can be gripped is 1½ in.

When the indexing chuck is not required it can be removed from the spindle and a 6 in. or 7½ in. 2-jaw or 3-jaw air chuck can be fitted utilizing the existing air equipment.

Whilst the air-operated turret indexing on the Flashcap minimizes idle time by limiting the amount of the return stroke of the turret slide which is normally required to index the turret, the principal advantage is that it greatly reduces operational fatigue on a rapid-cycle machine with a result that a constant high production can be maintained over an eight-hour shift.

The Herbert No. 5 Senior Preoptive capstan lathe is for bar work up to 2½ in. dia and chuck work up to 15½ in. swing. The design incorporates single lever operation of both transverse and longitudinal feeds to the saddle, which are reversible independently of those to the capstan slide; quick-acting, self-indexing square turret; twelve reversible power feeds from 30 to 480 cuts per inch to saddle and turret slide and automatic feed trips and dead stops are provided; Chiprupter which enables the operator to break into short safe lengths long continuous turnings produced by Chipstream boxtools; a taper-turning attachment operating in either direction for tapers up to 6 in. long and 25° included angle; single-shot lubrication to capstan slide; and a sixteen-speed power-operated Preoptive headstock which eliminates idle time due to speed changing; changes can be made under cut, if required. Large clutches transmit ample horse-power to the spindle throughout the entire speed range of 21–1500 rpm. A 10 hp motor is fitted.

The Herbert No. 9C combination turret lathe is a standard machine which has been equipped with a hydraulic copying attachment designed to reproduce profiles on components from master templates. These profiles may be longitudinal or transverse, internal or



All operations except chucking and removing the workpiece are automatic on the Herbert Auto-Junior. An alternative higher speed range is available

external. With this attachment the machine retains the characteristic versatility of the combination turret lathe, yet is capable of undertaking profiling work of a comprehensive nature. The attachment can be used separately or in conjunction with other tooling on the hexagon turret, which considerably reduces floor-to-floor times.

The profiling slide has a stroke of 6 in., is controlled by a sensitive hydraulic valve and has a safety device, ensuring automatic retraction if the slide is accidentally over-traversed.

The tools are carried in easily-detachable, accurately repositioned toolposts and the change from roughing to finishing tools can be accomplished quickly. Several types of toolholder are available including straight and angular holders for shank-type tools, clamped-tip and boring bar holders.

The template carrier mounted at the rear of, and which moves transversely with the cross slide, is stationary longitudinally whilst the stylus follows the template form during the longitudinal power feed of the saddle. The stroke of this carrier is equal to the full power traverse of the saddle and thus provides ideal conditions for the external profiling of long work. The carrier mounted on one face of the hexagon turret and accurately located by the overhead support bar provides two locations for fitting the template for transverse and external and internal longitudinal profiling on shorter work.

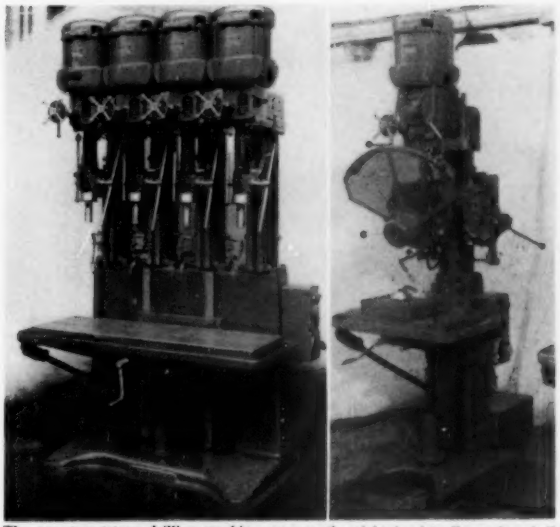
The setting of the profiling slide and use of either template carrier will depend upon the class of work to be machined.

The maximum swing is 22½ in. A similar machine, the No. 2C/30 with 30 in. swing is available.

A high-speed automatic chucking machine for continuous high production of work up to 8½ in. swing is the Herbert Auto-Junior. All operations, except chucking and removing the workpiece, are automatic, thereby enabling a number of machines to be run by one setter and one feeder.

The Auto-Junior has a standard speed range of 35–1484 rpm. Four reversible spindle speeds can be automatically selected during any one set-up and the machine can be used for such threading operations that require spindle reversal for withdrawal of the tool. Right- or left-hand, internal or external threads can be machined and the coarsest thread which can be produced is 10 t.p.i. (2·5 m/m pitch).

The exhibition machine operated on a duralumin component and had an alternative speed range of 53–2200 rpm which the makers supply as an extra:



The new turret-type drilling machine seen on the right is virtually a six-spindle machine. The four-spindle machine at left has standard top columns mounted on a common base

28 reversible spindle speeds are available in either range.

An entirely new addition to the range of Herbert drilling machines is a turret-type drilling machine which is virtually a six spindle machine. It can be accommodated on a floor area such as that normally occupied by a two-spindle machine. The machine has a hand-indexing, six-position turret mounted on a roller bearing and containing six No. 2 Morse spindles running in ball bearings. A single lever unclamps the turret and withdraws the plunger; after indexing, the same lever repositions the locating plunger, reclamps the turret and engages the drive for the spindle in the operating position. A self-selecting adjustable stop screw is provided for each turret station. Automatic reverse to any one or all spindles can be fitted for use when threading. Maximum drill capacity is ⅞ in. dia with a stroke of 5 in. Any one of eight speeds between 74 and 2850 rpm can be selected quickly and three automatic down feeds to the spindle, 88, 130 and 180, or 112, 165 and 230 cuts per inch, are available.

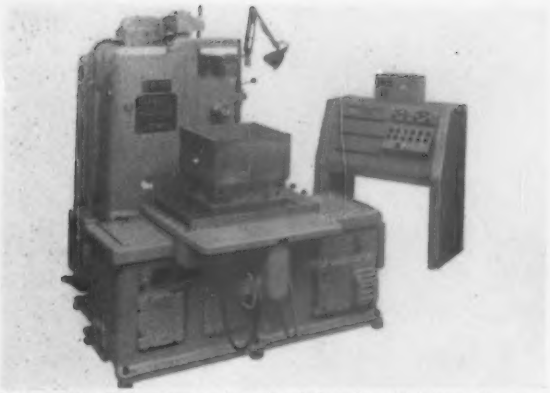
The Herbert 4-spindle drilling machine comprises a number of standard top columns mounted on a common base. Combinations of most top columns of ten types can be fitted to standard 2 to 6-spindle bases.

The machine exhibited was equipped with one Herbert No. 2 flash tapper, one Herbert Type V-Senior drilling machine, one Herbert Type V drilling machine with integral Coventry quick change drill chuck, and one Herbert Type C drilling machine with automatic reverse to the spindle for tapping.

This combination of top columns enables holes up to 1⅛ in. dia to be drilled at spindle speeds ranging from 104–1455 rpm and permits holes to be tapped up to 1¼ in. dia at a maximum of 30 pieces per minute.

The V-Senior unit is fitted with a new type of driving box incorporating a clutch speed change which permits each of the eight speeds to be selected whilst the spindle is rotating.

The DeVlieg Jigmil is a machine which because of its rigidity of structure and an accuracy of 0·0001 in. per ft for alignment has given rise to a now accepted method of production. Components ranging from instruments and guided missile parts to machine tools and diesel engines



A great variety of components can be made quickly and to a high degree of accuracy, and almost entirely without jigs and fixtures, on the Herbert DeVlieg Jigmil

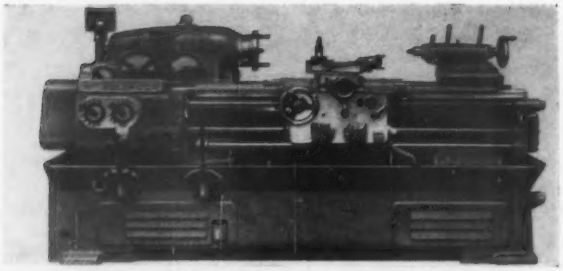
are now made, almost entirely without jigs and fixtures, faster and more accurately than at any previous period. The Herbert/DeVlieg 2B-36 Jigmil is built under licence in a special section of Messrs. Alfred Herbert's Lutterworth Works and is identical to the American-made machine.

One feature of the Jigmil which has contributed much towards its accuracy of performance is the automatic positioning system for the spindle head and table. This system in conjunction with measuring rods or Duplitrol bars, has for many years proved to be extremely accurate and reliable. It operates through a 2-speed, 3-phase induction motor, together with its associated high ratio gearbox, controlled by a repetitive switchgear sequence which traverses the slides and brings them to rest with a high degree of accuracy.

Developments, however, in the field of electronics have now given new systems of measurement and there is an alternative to the length bars and Duplitrol bars. These are called 'Herbert Datatrol', which is a dial and tape analogue control system. The Datatrol system is designed to reduce the possibility of operator error in setting co-ordinates, increase the accuracy of measurement and to give higher rates to output.

The new measuring system consists of 'Inductosyn' scales mounted on the bed and the column of the machine. These are glass scales 10 in. long on which is printed a flat electrical winding. Five-inch long sliders of the same nature as the scales are fixed on the spindle head and table. By inductive coupling an error voltage is produced in the scales which becomes zero when the slide is moved X distance from its datum. The distance X is selected by means of dials which give 0·0001 in. increments over the full range of the slides. The error voltage is amplified by transistors and converted to a d.c. voltage which also becomes zero. This zero or null signal is used to initiate the standard DeVlieg positioning cycle. The co-ordinates of a position may be set by either the dials or pre-programmed on punched paper tapers. Other signals can be obtained from the tape such as the co-ordinate number, side of index table, etc. The datum of the X and Y co-ordinates may also be moved to any position within the range of the machine.

By retaining the standard DeVlieg positioning system one does not become involved in the use or cost of servo-motors and their control gear. Therefore the amount of electronic equipment is relatively small and there is still the full power of the feed motors for slide movement. Transistors are used in the electronic equipment as they



Eminently suitable for very fine turning, the Holbrook Model 10C precision lathe has its spindle in Gamet bearings and the final belt drive pulley separately mounted

are less susceptible to shock than thermionic valves; and as very little heat is generated, the equipment can be built into sealed units.

The spindle of the Holbrook Model 10C precision lathe is worthy of note. It is fitted on Gamet bearings into a heavy section spindle head. The final drive is by belts and the pulley is mounted on its own bearings, thus relieving the spindle of all belt strain. With Gamet bearings the speeds are from 35–3000 rpm or alternatively it can be furnished with plain bearings and a super-finished spindle giving 23–2000 rpm. This latter arrangement makes the machine suitable for very fine turning operations.

Spindle speed changing is fast and positive by means of two levers on the bed. The machine has a very wide range of feeds (0·0006–0·040) and threads (2–120 TPI) and the smooth movement of the saddle combined with an highly accurate thrust—compensated leadscrews give accurate threading and fine finishes.

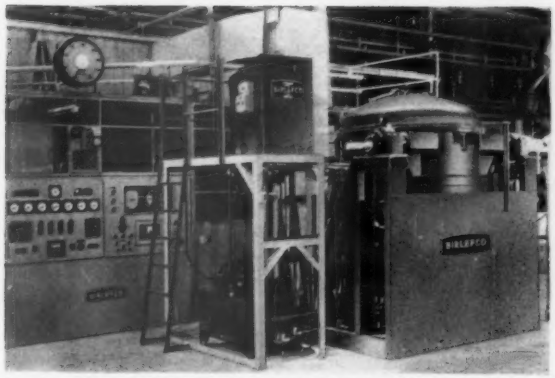
Features of the machine include: all motors and pulleys statically and dynamically balanced, all gears on the spindle drives hardened and ground and all other gears shaved, all leadscrews are supported in hardened and ground guide bushes adjacent to the nut, a turning test, which is checked on a Talyrond is taken on all machines to a maximum permissible error of 0·0001 in., all machines have a built-in taper-turning attachment and this is included in the standard price of the machine.

Metal Laboratory Furniture

The new Griffin-Grundy all-metal laboratory furniture is designed for economy and so that it can be packed easily in knocked-down form. It has corrosion resistant finish and is of rigid construction; doors, catches and other close-mating parts are already assembled in frames so that the final assembly may be carried out by semi-skilled labour easily and quickly. It is fire-resistant. There are no projecting handles on cupboards and doors. Instead a continuous flange offers a finger grip space over the full width of the door and drawer, thus ensuring a clean and flush appearance. The drawer tracks are adjusted for alignment by a simple cam in the front of the unit, while a rubber buffer ensures quiet operation.

All units have adjustable feet for quick levelling with plastics inserts at the base to prevent damage to floors and to deaden sound. The kicking panel, or base plinth, has ample tow space and fits snugly to the floor. To facilitate assembly all nuts and bolts are accessible from the outside and when they are once in place the "flashing" strip is snapped into position to conceal all fixings.

The new furniture is a product of Griffin & George Limited, Ealing Road, Alperton, Wembley, Middlesex.



Used for refining special alloys under vacuum, this plant employs main frequency which makes the electrical gear cheaper. The furnace, heated by a water-cooled induction coil, is housed in a vacuum tank mounted on trunnions operated for tilting by hydraulic cylinders. A retractable bridge carries the stream of metal

Low Cost Metal Vacuum Treatment

A new Birlefco de-gassing and vacuum refining unit which is relatively inexpensive but gives close control over temperature and pressure has recently been installed at the Birmingham Works of Henry Wiggin and Company Limited for the vacuum refining of special alloys. Basically it is a 15 cwt mains frequency induction melting furnace housed in a tiltable vacuum tank.

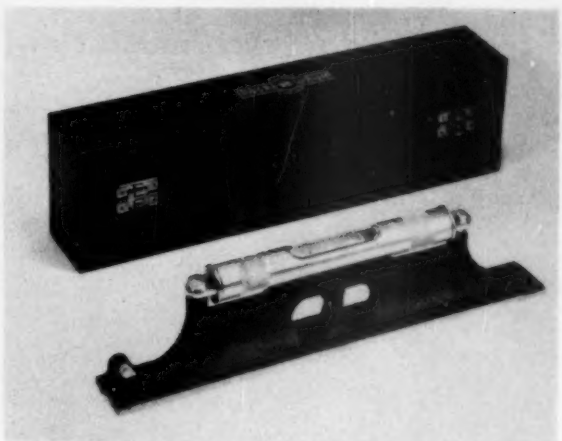
A water-cooled copper induction coil supported by a magnetically shielded steel framework forms the furnace proper. Mains frequency is used, which makes the electrical gear cheaper and gives high turbulence to the molten metal. Turbulence stirs the bath thoroughly and brings new metal to the surface where gases and volatile metals can be drawn off.

The installation has a rating of 300 kW and is arranged for connection to a low tension three-phase supply. This gives ample power for melting duty, though, for refining service only, a maximum rating of 200 kW would suffice.

The vacuum tank, which houses the furnace, is mounted on trunnions and tilted by twin hydraulic cylinders. The tank movement produces an approximately lip-axis pouring effect from the furnace, and a retractable bridge over the top flange of the tank carries the metal stream. Hydraulic controls open and close the vacuum tank lid and pneumatic clamps lock the lid on to the tank. The furnace mouth carries a refractory cover with holes to correspond with a viewing port in the chamber lid.

The vacuum pumping lines are connected to the tank concentrically with the tilting trunnion and are not demounted when the furnace tilts. The installation includes a three stage pump set which gives ample gas handling capacity over the whole range. Automatic controls maintain the correct pumping sequence and a dust trap protects the pump set from damage by fumes and metal splashes. Pirani and dial gauges monitor the furnace pressures.

The whole equipment was designed and made by Birlec-Efco (Melting) Limited, Birmingham 24, for use by relatively unskilled personnel with a minimum of technical supervision.



The new Moore & Wright 12 in. level has both main and cross rails with a rotating protective tube for the former. The accurately machined base is grooved to facilitate use of the level on cylindrical work or shafting

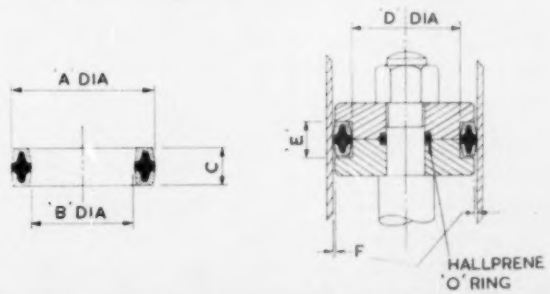
Twelve-inch Level

A useful addition to the well-known range of engineers tools made by Moore & Wright Limited, Handsworth Road, Sheffield 13, is a 12-in. level with main vial, cross vial and plumb vial. The main vial is ground and graduated 0·1 in. divisions and is housed in a chromium-plated brass tube. This tube is surrounded by a protector tube which revolves to protect the vial when not in use. Clear non-discolouring liquid is used in all the vials. The base is made of high grade cast iron, finished in black crackle enamel; it is accurately machined and is provided with a concave groove for use on cylindrical work or shafting. When the level is used on round work it is possible, by using the cross vial, to check any tendency to cant.

The level has the reference number 305/12" and its retail price is £5-5-0 in a well-made wooden case. We are informed that further sizes will be made as soon as possible.

Double Acting Fluid Seal

The new Hallprene patent double-acting fluid seal introduced by Hall & Hall Limited, of Oldfield Works, Hampton, Middlesex, is designed to eliminate many of the difficulties encountered in the design and operation of double-acting hydraulic pistons. It is based on the highly successful Hallprene patent fluid seal, and is fundamentally two impregnated fabric U-seals bonded to a rubber core. The seal can be mounted centrally in a groove on the piston spigot, filling the diametral clearance between spigot and cylinder.



The new Hallprene fluid seal for double-acting hydraulic pistons has two impregnated fabric U-seals bonded to a rubber core

Earth Leakage and Earth Fault Protection—III

Fault Current from Other Systems and Earthing Circuits

By J. L. WATTS

UNDER certain conditions an earth-continuity conductor which is adequately protected for a particular circuit might be called upon to carry fault current from another circuit.

It is usual for the exposed metalwork of a consumer's plant to be connected to earth by means of an earthing conductor connected to the metalwork at, or near, the main fuses or circuit-breaker; as by the conductor G connected to the casing of the main breaker C in Fig. 1. Normally earth-fault current through the earth-continuity conductor between D and E will be limited by the fuses in D, whilst the earth-continuity conductor between the breaker C and the distribution fuse box D must be large enough to carry earth-fault current up to

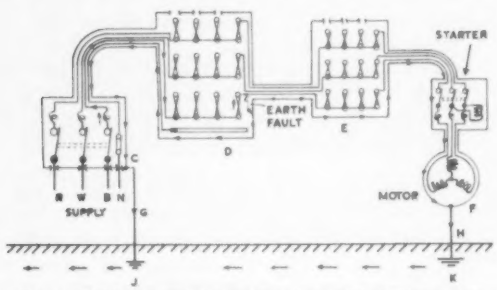


Fig. 1.—Division of earth-fault currents in parallel earthing circuits

the operating value of the excess-current releases in the breaker C. The earthing conductor G should be large enough to carry earth-fault current up to the operating value of the protective devices in the supply to this main breaker, since an earth fault on the supply side of this breaker will not be limited by the excess-current releases in the breaker itself.

Parallel direct earthing connexions

However, if there is another intentional or fortuitious connexion to earth, as in the case of the conductor H at the motor F, earth-fault current on the installation will flow through two parallel circuits to earth, as indicated by the arrows. The ratio

$$\frac{\text{Fault current through H}}{\text{Fault current through G}}$$

will be equal to

$$\frac{\text{Impedance between metal and earth via C and G}}{\text{Impedance between metal and earth via E, F and H}}$$

If there happened to be a fairly high impedance in the earth-continuity conductor between C and J, or a relatively high resistance at the main earthing electrode J, most of the fault current might pass to earth through H. This fault current does not pass through a fuse in the distribution box E, and is limited only by the larger fuse in D. Since the size of the earthing conductor is normally related to the size of the current-carrying conductors on that particular circuit there might be a risk of serious overheating of the earthing conductor H, or earth-continuity conductor from D to F, before the fuse in D melted. Safety against such risks is afforded by maintaining the impedance of the earthing circuit to the general mass of earth via J at a low value. If there is a fortuitious earthing connexion of low resistance at any point in a circuit, as to K, it is also desirable that the earth-continuity conductor to it should be of adequate size to carry the possible fault current to it.

Fire resulting from interruption of main earthing conductor

Fig. 2 indicates conditions which were responsible for a fire. In this case the exposed metalwork on the consumer's installation was connected to the earthed neutral point of the supply system by the metal sheathing of the service cable. An earth fault on the service cable caused the lead sheathing to melt at the point of fault and fault current passed to earth through a gas pipe which was making contact with the consumer's earthed metal. The

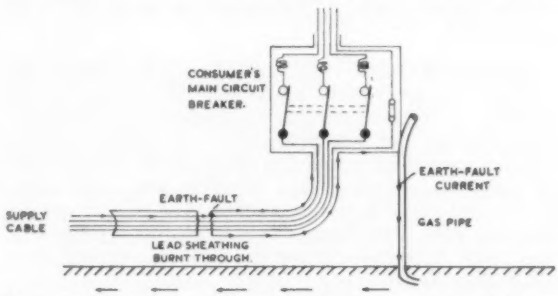


Fig. 2.—Earth fault on service cable passing fault current through an earthed system on the consumer's premises

latter defect is responsible for many fires. In this case, however, it is possible that the fire might have been avoided if an earth electrode on the consumer's premises had been connected to the exposed metalwork, although the fault current would have been limited only by the excess-current protective devices at the supply end of the service cable.

Fault current from another circuit

Fig 3 indicates possible conditions when the exposed metalwork on the consumer's installation is connected to

a local earth electrode as well as being bonded to the earthed neutral point of the system. In the event of an earth fault on a conductor which is not enclosed in earthed metal bonded to the system neutral point, the fault current will return to the neutral point of the system through the general mass of earth. Such a fault might occur on another consumer's plant as at A.

If the consumer B has an earth connexion of comparatively low impedance, coupled with a comparatively high resistance at the neutral-point earthing electrode C, some of the earth fault current from A may return to the neutral point of the system through the earthing system of B. The value of the fault current is controlled only by the excess-current device at A. These conditions also indicate the need for an adequate earthing system where a consumer's earth electrode is bonded to the neutral-point earthing electrode, and other non-bonded plant is fed from the same system.

Possible transformer faults

Where the exposed metalwork of a consumer B is connected to a local earth electrode D and is also bonded to the earthed neutral point of a supply transformer, as in Fig. 3, the consumer's earthing system may also have to carry fault current due to a defect in the supply transformer. For instance, if a short circuit occurred between the primary and secondary windings of the transformer, current from the high-voltage lines would pass to earth through the neutral-point earthing electrode C, and some fault current may also pass to earth through the consumer's earthing electrode D, especially if D had a low resistance compared with C. This current would be limited by the excess-current, or earth-leakage, protective devices in the high-voltage supply line to the transformer.

Similarly fault current may pass through the earthing system of the consumer B in the event of an earth fault on the high-voltage windings of the supply transformer,

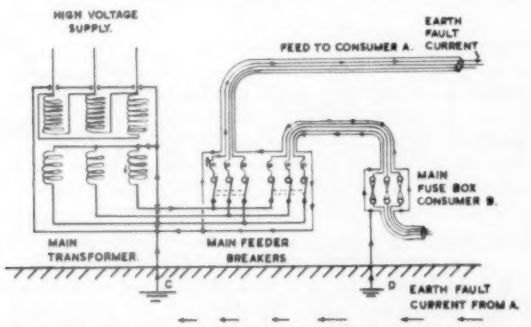


Fig. 3.—Possible effects with high-resistance neutral-point earthing electrode

unless the transformer core and case are earthed to a separate earth electrode which lies outside the resistance area of the neutral-point earthing electrode C.

Earthing point

In most cases it is advisable that the exposed metalwork on a consumer's installation shall be bonded together and connected to earth at one point, preferably near the service point. The Coal and Other Mines (Electricity) Order, 1956 requires that the exposed metalwork be connected to earth at the surface of the mine.

Separation from other services

All current-carrying and earth-continuity conductors should be firmly secured so that they cannot come into contact with other earthing paths. In particular the I.E.E. Regulations require that the metal sheathing and/or armouring of cables, metal conduits, ducts and trunking associated with cables operating on more than 30 volts a.c. or more than 50 volts d.c., and earthing conductors used on such systems, shall be prevented from coming into contact with radio, telephone, bell or sound distribution circuit, or in contact with other services such as water, gas or non-earthed metalwork. Such services may be incapable of carrying earth-fault current without risk of fire or electric shock.

Many fires are caused by earth-leakage curret, nor earth-fault current, passing to earth through gas pipes, usually due to fortuitious contact between the metalwork or earth-continuity conductor and the gas pipe. Where it is impracticable to separate the earthing system of the installation from such other services, or from non-earthed metalwork, the exposed metalwork should be carefully bonded to the other service to avoid risk of arcing in the event of an earth fault. Even so fires have resulted from melting or puncturing of a gas pipe at a point remote from where it was bonded to the earthing system.

These risks can be minimized by maintaining a low impedance between the exposed metalwork and earth and by keeping gas piping clear of the earth-continuity conductors and metal casings of the installation, and clear of other metalwork.

Effect of high-resistance connexions

Whilst, in general, the use of the correct sizes of fuses, correct setting of excess-current releases and the correct size of earth-continuity conductor, may ensure protection against the risk of fire due to overheating of a homogeneous current-carrying or earth-continuity conductor when carrying earth-fault current, there may be a risk of fire if there is excessive heating at a particular point in a conductor.

Such local heating, or even arcing, may occur if there is a high resistance in a conductor due to a faulty connexion. 400 watts is generated at a faulty connexion having a resistance of only 0·01 ohm when 200 amp passes

Table 1.—MAXIMUM CONTINUOUS RATE OF HEATING PERMITTED BY VARIOUS FUSES AND CIRCUIT-BREAKERS AT A 0·01 OHM CONNEXION IN THE EARTHING CIRCUIT

1	2	3	4	5
Current rating of fuse or circuit-breaker	Maximum continuous heating at a 0·01 ohm connexion permitted by a fuse with fusing factor 1·25 or breaker set at 25% overload	Maximum continuous heating at a 0·01 ohm connexion permitted by a fuse with fusing factor 1·5 or breaker set at 50% overload	Maximum continuous heating at a 0·01 ohm connexion permitted by a fuse with fusing factor 1·75 or breaker set at 75% overload	Maximum continuous heating at a 0·01 ohm connexion permitted by a fuse with fusing factor 2·0 or breaker set at 100% overload
amp	watt	watt	watt	watt
5	0·39	0·56	0·76	1
10	1·56	2·25	3·05	4
15	3·51	5·05	6·85	9
20	6·24	9	12·2	16
30	14·04	20·5	27·5	36
40	24·96	36	48·8	64
50	39	56	76	100
60	56	80·5	110	144
80	100	144	196	256
100	156	225	305	400
125	243	350	475	625
150	351	505	685	900
175	480	690	935	1,220
200	624	900	1,220	1,600
250	975	1,400	1,900	2,500
300	1,404	2,050	2,750	3,600
350	1,900	2,730	3,720	4,900
400	2,500	3,600	4,880	6,400
500	3,900	5,600	7,600	10,000

through it. Table I shows the maximum rate of heating permitted by various fuses and overload circuit-breakers at a connexion in a current-carrying conductor which has a resistance of 0·01 ohm. The current will normally be cut off in about a minute if the rate of heating at the connexion exceeds the listed values. It will be noted that a fuse of low fusing factor affords greater protection than does one of higher fusing factor.

The values given in Table I also refer to the maximum continuous rate of heating permitted at a connexion of 0·01 ohm resistance in an earth-continuity conductor should an earth fault occur on no load. On load the continuous rate of heating of a high-resistance connexion in an earth-continuity conductor is reduced due to the load current also passing through the fuse or overload circuit-breaker. The maximum continuous rate of heating permitted at a faulty connexion is proportional to the resistance of the connexion.

A high resistance connexion in a current-carrying conductor may occur at a fuse, starter, switch, motor or other appliance, or may be due to a faulty contact. A high resistance connexion in an earth-continuity conductor may increase the risk of earth-fault current passing through some other earthed metal, such as a gas pipe, and may prevent the protective devices operating at all. All connexions should be made clean and tight, and all connexions which are subject to vibration should be made secure with lock nuts or spring washers. All connexions and contacts should be examined periodically.

Causes of high-resistance connexions

An earthing connexion may have a high resistance due to it not having been properly cleaned and/or tightened in the first place, or may result from corrosion, vibration, "flow" of lead sheathing of a cable under an earthing clip, or melting of solder in a connecting lug.

One of the difficulties which may be experienced in using conduit as the earth-continuity conductor is that the resistance of a series of conduit joints may add up to an appreciable amount in a long run. High-resistance at a screwed conduit joint is frequently due to the use of worn dies to cut the threads, or the joint not being pulled up tight. A slack joint in a conduit may have quite a low resistance when new and clean, but may develop a high resistance later due to moisture setting up corrosion and/or vibration causing relative movement of the conduits. Protective pastes, such as lanolin compounds, red lead or atomized lead on the screw threads may tend to raise the initial resistance of the joint, but where there is a possibility of corrosion their use is often justified by the protection they afford against deterioration of the joint in service. On a screwed conduit joint it is advisable to use at least one lock nut on each section of conduit if a suitable protective compound is not applied to the threads. Grip-joint conduit should be avoided, especially on outdoor installations.

Sound earthing connexions

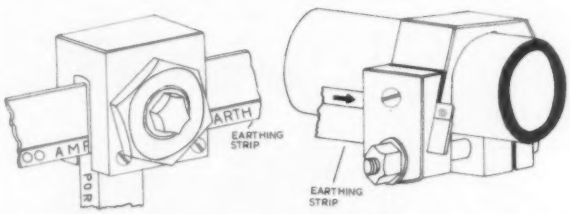
Metal casings, etc., should be carefully cleaned where an earthing connexion is to be made. The best connexion between metal conduit and a metal casing is obtained when the conduit is screwed into a tapped hole in the casing and is locked. If the casing is not thick enough for this type of connexion it is sometimes desirable to supplement the connexion between the conduit and the casing by an additional earthing conductor fixed to the casing at one end, and fixed to the conduit by means of a strong clip at the other end.

Where several metal casings, such as items of switchgear, are screwed together the joints between the casings may introduce an appreciable resistance in the earthing circuit. It is advisable that a substantial copper strip be connected between the metal sheaths or conduits of the incoming and outgoing cables, this being bonded to the various casings. Earthing connexions should be secured to metal casings by proper lugs, or claw washers, and there should be no risk of a soldered connexion becoming open-circuited due to melting of the solder by earth-fault current. No earthing conductor should be fastened to a bolt or screw which holds a cover in position, since the connexion may be left off, or not properly reconnected, when the cover is removed.

Use of a separate earth-continuity conductor

The risk of high-resistance joints impairing the protection can be minimized by using an earth-continuity conductor having a minimum number of joints, such as a mineral-insulated metal-sheathed cable, a lead-sheathed or armoured cable, or a separate earth-continuity conductor; periodical inspection and testing to reveal any faulty joints, the use of an earth-fault protective system which operates on low fault currents, as described later, and keeping combustible materials clear of earth-continuity conductors. The need for good connexions is stressed in regulations.

Portaway strip earth-continuity conductors are available in various sizes which can be fitted without any drilling, riveting or sweating, by the use of a simple hand punch. Fig. 4a shows the patented Portaway clamp for connecting together such earthing strips; whilst Fig. 4b shows the Fulgrip clamp which may be used to connect this strip to water pipes, conduits, etc.



Porter Electrical Products Ltd.

Fig. 4.—Some of the clamping devices employed on Portaway earthing systems. Left, teeing-off conductor clamp; right, T.I.C.-P. bonding clamps

It is of interest to note that the practice of companies of the American G.E.C. for earthing the framework of machines and equipment is to run a separate earth continuity conductor from the earthing point at the source of supply to the equipment concerned, except where the lead-sheathing of the cable can be used as the earth-continuity conductor. The separate earth-continuity conductor is run inside the conduit or ducting, or inside the sheath of a multi-core cable. Tests have shown that where circuit conductors are enclosed in conduit, cable armouring, etc., and the earth-continuity conductor is remote from them, the metallic enclosure of the circuit conductors will carry the major portion of earth-fault current.

When alternating earth-fault current passes through a circuit conductor and back through the metal sheathing of that conductor the magnetic effect of the currents flowing in opposite directions is largely neutralized, thus reducing the reactance and impedance of the path. No

such neutralization occurs when fault current flows through an isolated conductor, so that an isolated earth-continuity conductor may have an appreciable reactance and impedance.

The impedance of a conductor is equal to $\sqrt{R^2+X^2}$ ohms, where R is the ohmic resistance, and X the ohmic reactance of the conductor. The resistance of the conductor is proportional to $(S\times D)/A$, where S is the specific resistance, or resistivity of the conductor material, D the length of the conductor, and A its cross-sectional area. The reactance X is due to magnetic flux created by the current in the conductor, which alternating flux induces an e.m.f. (voltage) in the conductor. X is proportional to $f\times L$, where f is the frequency of the alternating current, and L the coefficient of self-inductance of the conductor, which depends on the change of magnetic flux produced per amp change of current, or roughly on the flux produced per amp. In a d.c. circuit the earthing conductor possesses reactance only whilst the fault current is increasing or decreasing. In an a.c. circuit, of course, the current changes continually, and there may be an appreciable reactance and impedance if the fault current is allowed to create a strong magnetic flux.

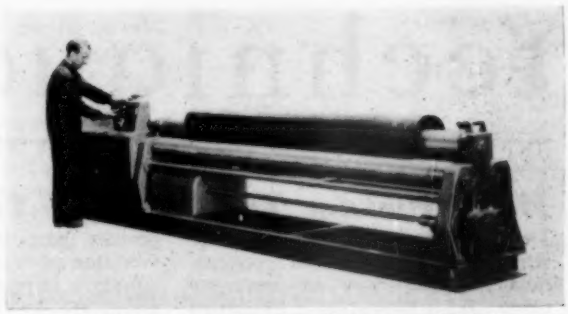
The purpose of running a separate earth-continuity conductor inside conduit is to avoid reactance of a remote earth-continuity conductor causing a high proportion of the earth-fault current to pass through the parallel-connected conduit should an earth fault occur, since overheating might then occur at a loose or deteriorated conduit joint. The practice of the U.S.A. G.E.C. is to use in the conduit or cable duct a stranded earth-continuity conductor which is one size smaller than the current-carrying conductor. For sizes up to about 0·05 sq in. the earth-continuity conductor has a flame-resistant covering, although larger conductors may be bare.

There may be a risk of fire due to overheating of an appliance due to earth-fault current or arcing at the point of insulation failure. Both risks can be minimized by using a protective system which automatically cuts off the current quickly at fairly low values of earth-fault current. The former risk can also be minimized by means of closely-rated fuses of low fusing factor, or overload circuit-breakers of low current setting; or by fitting in the appliance a thermal device to cut off the current in the event of overheating due to any cause.

Fire risks due to arcing are also minimized by using appliances having casings in which the arcing can be confined; enclosing the appliance in a fire-resisting enclosure, which may need ventilating, and by keeping inflammable materials away from the appliance. Special precautions may be necessary where a particular fire hazard exists due to the presence of inflammable or explosive gases, vapours of liquids. In such places flameproof appliances, switchgear, and conduits, etc., may be required.

New Besco Plate Bending Rolls

An entirely new range of Besco pyramid type plate bending rollers, with capacities of 6, 8 and 10 ft by $\frac{3}{8}$ in., $\frac{1}{4}$ in., and $\frac{3}{16}$ in. mild steel respectively, has been introduced by F. J. Edwards Limited, 359–61 Euston Road, London NW1.These machines, now in full production



Pyramid type plate bending rollers with power controlled feed

at Chard Works, have many of the advantages usually associated with heavier machines, notably their easy and accurate adjustment.

Adjustment to the top pressure roller for various radii, and the actual feeding of the plates through the rollers are under power control, and a screw-operated rise and fall self-support to the top pressure roller, around which plates are formed, frees the plate for withdrawal from the machine. The bearing at the opposite end to the support drops downwards, leaving the roller end absolutely free for withdrawing complete cylinders.

These Besco machines are robustly constructed. Pyramid roll formation is used with the two 7¼ in. dia bottom rollers supported in fixed bearings and at close centres, so that the flats at start and finish of the work are reduced to a minimum. The 8¼ in dia pressure roller is in adjustable bearing blocks, a formation which gives the best results in plate bending.

The top pressure roller is adjustable for various radii through a separate 4 hp motor from push buttons on the main control panel and the motor is fitted with a magnetic brake: limit switches with adjustable stops give precise control to this roller. The main feed roller drive is supported on the base and the drive comprises a 7½ hp slip ring motor with V-link belt drive to the single reduction worm gear unit and machine cut pinions on the feed roller ends. A magnetic brake is coupled to the gear-box input shaft to prevent overrun. Reverse direction of feed is obtained by joystick reversing controller on the main control panel. A safety device prevents the machine from running unless the top pressure roller support is released.

The overall height is 47 in. and the floor space is 29 in. × 134 in., 161 in. and 185 in. respectively.

Silicone Rust Inhibitor in Aerosol Container

A new addition to the range of Ambersil products marketed by the Amber Chemical Company Limited (11A Albemarle Street, London W1) is "Electrospray", composed of a silicone based anti-tracking fluid containing a rust-inhibitor, packed in an Aerosol container. It is for use on cable plugs and sockets, leads and all electrical equipment where good surface insulation is required under high humidity conditions. The product has high surface resistivity, is clean, inert, water-repellent, non-inflammable and has anti-stick qualities. The Aerosol pack gives easy application—one pass over the surface to be treated gives a thin, even, protective film and a high degree of penetration.

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Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Metal Powder Tools Reduce Vibration

The excellent damping capacity and relatively low cost of copper-infiltrated iron powder parts are being used to advantage in the design of cutting tools. The use of powder metallurgy for boring bars, shanks, milling cutter bodies, etc., results in longer operating life, better surfaces, closer tolerances and faster cutting speeds, according to Horace Frommelt, Director of the Metal Cutting Centre of Spring Garden Institute*. The main reason for these advantages is the substantial reduction of vibrations.

It is generally known that vibration of tools in the machining of metals causes reduced tool life, inaccuracy and poor surfaces. Two types of vibrations are encountered: forced and self-induced. Forced vibrations result from the mechanical operation of pushing the cutting tool against a workpiece. The frequency of these vibrations depends upon the mechanical source. Self-induced vibrations, the more troublesome of the two, are self-perpetuating and depend upon the nature of the material composing the shank and the forces inherent in the cutting operation.

In order to prevent, or reduce, harmful self-induced vibrations, designers have been specifying materials with a high modulus of elasticity, such as solid carbide or the so-called heavy metals. This solution is justified because the higher the modulus, the lower the ratio of stress to strain, and hence the lower the tendency on the part of the cutting forces to distort or displace the tool. However, these materials are too expensive to be practical.

The search for low cost materials with good damping characteristics led to plastics. Although epoxy proved quite useful from the point of view of vibration damping, it was discarded because it could not withstand high temperatures. Epoxy-bonded iron powder parts were better, but not good enough for the same reason.

Investigations conducted over the last four years indicate that metal powder parts solve most of the vibration problems. On the average, vibration in powder metal shanks is about 50% less than it is in identical steel shanks, this excellent damping effect is obtained when the iron particles are held in a matrix of copper.

A variety of cutting tools has now been made with copper-impregnated iron powder bodies and shanks. The carbide or ceramic cutting elements are inserted in slots formed during the briquetting phase and are locked firmly and securely in place by the shrinkage that takes place during the sintering and infiltrating phase. Tensile strength of these parts is in the neighbourhood of 70,000–80,000 psi. It is possible, however, to heat treat the parts to tensile strengths as high as 120,000–140,000 psi.

The use of powder metallurgy for tooling has made possible certain operations that were either previously impossible or extremely time consuming. A typical example being that of a steel sleeve heat treated to Rockwell C50 which was sucessfully bored in less than one minute with ceramic cutting elements set in a powder metal boring bar. It previously required two hours to grind —and the finish was inferior.

* From *Materials in Design Engineering*, July 1959, 179, 180, 182

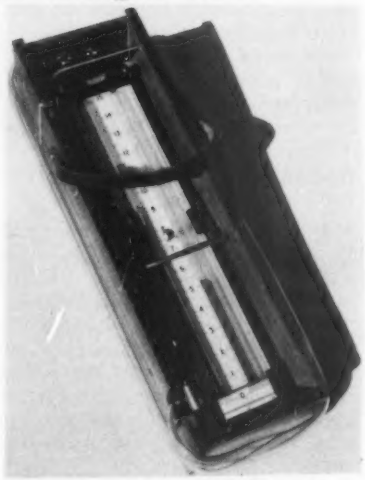
Fan Performance Recording Outfit

A portable outfit, suitable for underground use, to measure the performance of auxiliary fan installations, has been designed by Mr. P. Thorp, area ventilation engineer, No. 7 Area, East Midlands Division, and has been used successfully at a number of pits in the area.

It is required by statute that the quantity of air being delivered or exhausted at the end of a ventilation ducting must be measured at least once a week for all underground auxiliary fan installations. There are two generally accepted methods of carrying out these requirements, one involving the use of an anemometer or velometer, and the other employing a combined pitot-static tube.

An accurate method of determining the quantity of air flowing in a ventilation ducting is by using a combined pitot-static tube to record a series of velocity pressures. Such pressures are measured by a pressure gauge which is usually mounted on a mining tripod. Mr. Thorp's outfit enables this normally rather cumbersome method to be used as standard pit practice.

It will be seen from the accompanying photograph that the apparatus is compact and is supplied in a mahogany case for easy portability. It consists essentially of a twin tube inclined manometer with two "switch-off" taps; two levelling bubbles set at right angles; a specially designed combined pitot-static tube, and two 10 ft 6 in. lengths of clear p.v.c. tubing connecting the pitot-static tube to the manometer. This tubing need never be disconnected. A three-foot walking stick is provided which also acts as an extension rod for the combined pitot-static tube.



Portable unit for measuring fan performance

The manometer has an overall length of 17 in. and is completely covered by a Perspex sliding scale, which has the graduations on the underside to facilitate reading. The scale also serves as protection for the glass limbs of the manometer. The manometer is set at an inclination of 1 in 7·5 and levelling is

achieved by the use of two wooden wedges. By closing one of the two switch-off taps a reading can be "fixed" and read off at leisure, thus enabling the apparatus to be used easily by one person.

The combined pitot-static tube, specially designed for the outfit, is 18 in. long. It is graduated at ½ in. intervals and fitted with a movable pointer so that it can readily be placed centrally in the ventilation ducting and parallel to the airflow. The tube can only be clipped in the position shown on the photograph when both taps are in the off position, and this ensures that no liquid can be lost during transportation.

The outfit can be used in ducting up to a maximum of 30 in. dia, can record a maximum static pressure of 12 in. water gauge and a maximum air velocity of 13,500–14,000 ft per min. Air velocities in excess of 4,200 ft per min require to be measured with the gauge held in the vertical position.

Tables are used in conjunction with the outfit for converting velocity pressure readings direct to corrected average velocity.

The outfit weighs less than 10 lb.

Making Wire-covered Plastic Hose

For three years at Hoover Limited's Abbey Road Works, Wembley. Middlesex, Hooverflex "Double-Stretch" hose has been made for use with the cleaning tools of Hoover cleaners. Plastic chips are fed into an extruding machine through a hopper, passed along the extruder barrel and subjected to a gradually increasing heat up to a maximum temperature nearly 400°F. The chips fuse into a doughy consistency which, at the end of the barrel, is forced through a moulding system where, inflated by compressed air, the sleeve flows out.

After cooling in a water trough the sleeve is passed on to a conveyor belt, the wall thickness being governed by the speed at which the belt is operated. At the end of the belt, the sleeve is marked into correct lengths, flattened under a steel roller and reeled on drums, each finally carrying over 400 ft.

Side-by-side with the sleeve-extruding line is the plant for covering with plastic the steel wire of the hose spring. The wire is unreeled from a drum and passed through a cleaning trough into a 10 ft. long heated chamber. After coming out of the chamber, it goes through an extruding machine to get a covering of soft plastic which is then hardened by water-cooling. The diameter of the plastic coating is automatically controlled by a photo-electric device.

The spring is formed by an electronically-controlled machine and automatically cut into the required lengths as the end advances down a guide channel and into the beam of a photo-electric eye. An assembler standing by the machine makes regular checks on the diameter and tension of the springs.

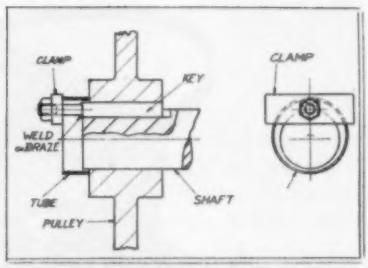
The plastic tubes and the spring are assembled on special purpose machines at which operators deftly stretch newly-made springs over long, plastic-covered aluminium tubes. The plastic covering is slightly inflated, to hold the spring firmly in place at the correct length. Then, also inflated, a length of hose sleeving is drawn over the spring by a mobile carrier mounted on rails.

Removing Tight Keys

Despite the numerous different methods of removing keys from pulleys—methods which are essential because keys are so often tight or inaccessible and a direct hammering behind them is impossible, and a draw from one end is necessary—still further ideas are constantly arising; each is ingenious and all of them do the job satisfactorily. One more example which was observed recently being used by a millwright is seen in the sketch, and it broke the seal of heavy rust and drew the key without difficulty.

The key was of square section but the rear end was completely obstructed by the box casting of the machine, making it impossible to get behind it and drive it with the usual drift and hammer. Fortunately the machine pulley was at floor height and welding on a cut-off portion of a bolt was not difficult, but care was obviously necessary to prevent the weld metal from adhering to the shaft.

Once the stud was welded in place it was a simple matter to put a length of tube over it and arrange a flat plate clamp. The key was drawn easily after the initial crack which disturbed the rust. Sawing off the stud made the key again fit for use.



Straight keys rusted to a pulley are easily withdrawn by welding of a short length of cut-off bolt to the key end. A high tensile bolt is advisable

An advantage with this withdrawal idea is that heat from the welding torch can also heat the wheel boss and so expand it a little and facilitate dismantling, but generally in bad conditions a high tensile stud is essential to avoid stretching.

Economical Rig for Boring Bush Housings

The successful use of two Wandess cylinder boring bars linked in tandem to provide a multi-boring unit has provided, for less than £400, an alternative to a multi-headed static boring machine, costing between £1000 and £3000, which would otherwise be required for the same job.

As reported by Stenor Limited, Kew Foot Road, Richmond, Surrey, the agents for Wandess equipment, the boring bars used are the 2A geared headed standard type which incorporate a rigid boring head and a special tool lapping jig. They are accurate to 0.0002 in. ovality and taper, and produce a sleeving cut of 0·125 in. in one operation. The bore ranges between 2·2 in. and 4·2 in. dia to a depth of 10½ in. at a maximum rate of cut of approximately 1·25 in. per min. Smaller and larger models are available.

The application has been developed by Landmaster Limited, of Hucknall, for the boring of two bush housings in the pressed casing enclosing the primary drive from motor to wheel axle of the new L.150 rotary cultivator. The boring bars are mounted on a jig, which is in turn mounted on a boring table. The casing to be bored is held in place by five small hydraulic rams acting on suitably placed cross bars. Jig, boring table and pneumatic system were designed and assembled by Landmaster engineers. Stenor Limited will be happy to advise other manufacturers on the development of similar assemblies for individual boring patterns.

This new Megger applies full mains voltage to the circuit under test and has a ballistic meter which, while it limits the duration of the test, maintains the dial reading until it is reset. Figures on the instrument enable the meter reading to be translated immediately into fuse ratings or circuit breaker settings

New Line Earth Loop Tester

A new instrument in the "Megger" series has been designed by Evershed and Vignoles Limited which involves a basically new thought on the subject of line earth loop testing, i.e. testing of circuits which will carry current to earth in the event of a fault. With this instrument the full mains potential is applied to pass a current of approximately 20 amps through a circuit consisting of the live conductor, the earth continuity conductor and the earth return path. In other words the instrument passes the test current through the actual fault path and the indicating instrument employed may be calibrated directly in terms of the resistance of this path. This type of test is called for in Regulation 507 of the I.E.E. Wiring Rules.

A ballistic meter is used, as for obvious reasons the test current must be of limited duration. The ballistic meter will, however, maintain the reading after the current pulse has declined. A synchronous motor, energised through a push button switch, drives a contactor which connects a 10 ohm resistor from the live conductor to earth for a period of 5 cycles (i.e. 0·1 sec). The current during this period will be of a value determined by the 10 ohm resistor plus the actual resistance of the fault loop in series with the 10 ohm resistor. The meter, which is connected in parallel with the resistor, can thus be calibrated in terms of the loop.

The motor is automatically switched off when the current pulse has been passed, and the instrument embodies facilities for the resetting of the pointer of the ballistic meter after completion of the test.

The importance of the mains potential on the calibration of the instrument will be apparent and a mains voltage selector has therefore been included in the instrument which has to be adjusted to the mains voltage of the locality where tests are to be undertaken. This is adequate where the mains voltage is known precisely, but an auxiliary voltmeter can be supplied integrally with the instrument and may, in fact, become essential where tests have to be carried out at the end of a long feeder. To ensure the correct polarity of, say, a 3-pin socket, an indicator has been provided which lights up when the polarity is correct.

The resistance measurement obtained on the ballistic instrument may be related to the required fuse ratings for the circuit under test. A table is affixed to the instrument with which the readings on the meter may be instantaneously translated into fuse ratings or circuit breaker settings.

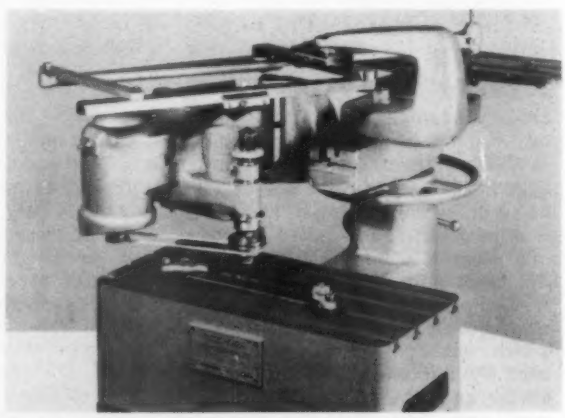
Apart from the earth loop tests, the instrument can be used for determining the actual earthing efficiency of an electrical appliance. Jack plugs are fitted to the instrument which modify the test circuit in such a manner as to connect the metal frame of the appliance and the attached earth conductor of the mains lead of the appliance, so that the resistance of the path may be measured. In this test, again the instrument imposes the same load conditions on the earthing circuit which might occur in the event of faulty insulation in any section of the appliance. Three-phase circuits may also be tested, a switch being provided for convenient switching from single to three phase.

New Desiccants for Moisture Control

The Mobil Oil Company Limited has introduced two new products, Mobil Sorbead-R and Mobil Sorbead-W. These products, or "desiccants", have been formulated to effect moisture control in surroundings where the presence of water vapour may cause difficulties. Moisture control, or dehumidification, is brought about by adsorption of the water vapour from its surroundings by the drying agent itself.

The problems caused by the presence of water vapour extend from the rusting of machinery and metal to the deterioration of many products, such as foodstuffs and textiles. It may also hinder the effectiveness of refrigeration plant and cause undesirable condensation during the manufacture and handling of compressed gases such as carbon dioxide and oxygen.

Mobil Sorbeads have a bead structure which has certain advantages, particularly in dynamic dehumidification systems. Mobil Sorbead R is recommended for the widest use, while Mobil Sorbead W has been developed as a specially resistant bead for use where the presence of liquid water has to be taken into account.



BENCH PANTOGRAPH.—This small bench-type pantograph engraving machine has been produced by Taylor, Taylor & Hobson, of Leicester. Priced at £150 it is capable of the high quality and accuracy of the larger machines. Its range of reduction ratios is from 1:1 to 16:1. A simple cutter-grinder attachment is available for use with the pantograph

Some New Alloy Metals

It is sometimes overlooked that intensive research in the metallurgical field periodically produces new alloy metals with actual or potential properties of industrial and economic importance. In the following notes some of these alloys are described and the purpose behind their development suggested

THERE has been a considerable use made in recent years of alloys containing copper and beryllium because these alloys are easily formed when suitably heat-treated and can also be hardened by ageing to give a hardness of 35 to 38 Rockwell-C (327–353 Brinell). They have proved advantageous for mechanical and current-carrying springs, but the widening use of both copper and beryllium was felt to carry with it a threat of future shortages of these elements and their alloys. Consequently, an attempt was made to discover an alloy that could be useful for those springs not requiring the maximum strength given by the copper-beryllium materials (54 to 62 tons per sq in. yield strength, 71 to 80 tons per sq in. ultimate tensile strength).

The result has been the introduction of an age-hardening, copper base alloy containing about 10% nickel, 1·5% silicon and 4·0% aluminium. This is easily formed in the solution-treated condition and is age-hardenable to give the following properties: yield strength 54 tons per sq in.; tensile strength 62 tons per sq in.; elongation 8%; modulus of elasticity 19,000,000 psi; proportional limit 38 tons per sq in., electrical conductivity 11% of copper.

If the alloy is cold worked, these properties can be improved. After cold working to the extent of 15% and ageing, the values obtained are as follows: yield strength 58 tons per sq in., tensile strength 64 tons per sq in., elongation 5%, proportional limit 46·5 tons per sq in., modulus of elasticity 19,000,000 psi. It is considered that this alloy is quite suitable as a substitute for copper-beryllium alloys for those applications where the exceptionally high tensile strength given by copper-beryllium is not necessary. For example, the material is suitable for producing spring contacts for employment in different types of office machinery.

The development of the gas turbine, the turbo-supercharger and, more recently, the mass production of jet engines, has created a demand for new metals capable of withstanding the extremely high temperatures and stresses met with in service. One of the most widely used of the "superalloys" which have sprung up as a result contains 16% chromium, 25% nickel and 6% molybdenum. The main use for this material is in the production of turbine wheels. Because of the high nickel content of this alloy, nickel being of strategic importance, it has been desired to reduce the amount of nickel in the composition without surrendering the characteristics that make the new metal so valuable. The chromium content is essential if the parts are to resist corrosion and oxidation in service. The molybdenum is essential to maintain the necessary strength at high temperatures. The carbon content is a maximum of 0·12% to ensure satisfactory forming and welding properties. The high nickel content is required to give the alloy the austenitic microstructure.

Nevertheless, it was decided that if a fully austenitic structure could be obtained in some other way, then a proportion of the nickel could be reduced. The most logical substitute for nickel was manganese, which has previously been used as a substitute for nickel in austenitic stainless steels by those countries short of the element. It was found in the end that 10% of the nickel could be omitted as long as it was replaced by 6% manganese, and the altered alloy would be quite as effective as the original except, perhaps, when kept in service for more than 1000 hr at 760°C. The elongation at fracture for the modified alloy was higher under all conditions. Precipitation hardening effects make the alloy somewhat stronger but do not seriously affect ductility.

Finality is not considered to have been reached as the new alloy has still to be produced in large quantities with uniformly high quality, but it is believed that vacuum melting may offer a possible solution, combined with simpler cold working techniques suitable for the rims of turbine wheels.

Early interest was aroused by the development of a range of what are termed "alpha molybdenum" steels with a low carbon content. The specially interesting feature of these alloys was their resistance to "heat-checking", i.e. the formation of cracks as a result of subjection to elevated temperatures. This type of fault is often experienced in die blocks for the hot working of metals, and it was felt that this new range of steels might be suitable for the purpose. However, while the resistance to heat checking was satisfactory, the impact properties did not prove all that was desired. Nevertheless, results were promising enough to suggest that some modification of the composition might succeed in producing new hot-working die steels of improved performance.

After extensive experiments and tests, it appears to have been established that a steel containing 0·2% carbon, 3·0% nickel and 3·0% molybdenum, when suitably tempered, gave the highest impact properties. In press and machine forging operations it was found that improved production could be obtained by reason of the progressive ageing of the block surface during use, and the steel's ability to resist heat checking and premature failure arising from this. Ageing during service was effected by starting work with the blocks in an underaged condition.

There has been a tremendous amount of activity in the field of high temperature alloys. It was originally desired to produce a range of ferrous alloys containing chromium and nickel which could be used for super-chargers. This led to the introduction of nickel and cobalt base alloys of the precipitation hardening type for parts of jet engines. Research in this direction continues, but during the last few years a new subject for research has been the attempt to produce economically

alloys that will support severe loads at high temperatures, yet use the minimum amount of strategic elements. The increasing possibility that such alloys may be applied to the mass-production of automobile gas engines has intensified this aspect of research.

One direction it has taken has been to investigate the development of ferrous austenitic alloys capable of service within the temperature range 650° to 760°C. We have already seen that by using manganese to replace 10% of the nickel, something has been achieved towards this end. But is was felt that the hot strength, toughness and ductility of these newer alloys could be increased still further, while yet retaining the austenitic structure, by adding nitrogen, which has the ability to form austenite to a marked degree. Nitrogen also has other effects.

It was found that alloys containing as a basis 16% chromium, 14% manganese, 2% molybdenum and 0·5% nitrogen have properties at elevated temperatures equivalent to those of the 16.26.6 alloy earlier mentioned, within the temperature range of 650° to 760° C. They had, in short, adequate hot strength and ductility together with the retention of the austenitic microstructure. The ductility values, as well as the yield and tensile strength values, were generally better than those of the commercial austenitic stainless steels. In the cold-worked condition these new alloys have both a high tensile strength and good residual ductility. Their oxidation resistance is about the same as that of the equivalent stainless steels. Welding by normal techniques can be carried out, with one possible exception.

As an alternative to titanium alloys, zirconium alloys have been investigated since 1949, because the two types of alloys have many similarities. The primary purpose was to develop a range of creep-resistant alloys. At the time of writing, this research is only in its first and early stages, but already zirconium alloys have been introduced that will support a load of about 4·5 tons per sq in. at 500° C with less than 1% total deformation in 1000 hr. These alloys are of binary type and contain, in addition to zirconium, such alloy elements as molybdenum, columbium, tantalum and vanadium. They can be heat-treated, have a wide range of mechanical properties, and are readily hot-fabricated. They have good strength and ductility at room temperature. One point to be noted, however, is that if they are heat-treated to give higher strength, a sharp fall in ductility may be experienced.

The use of zirconium in reactors for atomic energy has also caused a demand for alloys of this metal that will be strong at elevated temperatures, corrosion-resistant, and of low neutron absorption. This has led to research into the use of chromium as an alloying element with zirconium. Results, so far, do not appear to have been conclusive. Germanium has also been alloyed with zirconium, but here, too, practical results are not yet apparent.

An interesting new material is an austenitic alloy for use at high temperatures. Preliminary evidence suggested that cobalt-containing titanium alloys (more than 3% titanium) would give satisfactory high temperature properties even if there were no aluminium in the alloy composition. When large scale vacuum melting techniques became available, it became commercially possible to produce alloys with a high enough titanium content to show precipitation hardening at elevated temperatures without undue formation of nitrides and loss of titanium. The basis composition is 1·3% iron; 29% nickel; 39% cobalt; 19·9% chromium; 6·6% tungsten; 4·1% titanium and 0·2% carbon.

With increasing applications for titanium and its alloys in high speed aircraft, it has been necessary to develop a higher strength titanium sheet alloy capable of being heat-treated to give an ultimate strength of 76 to 80 tons per sq in. and having good strength and stability under stress in the heat-treated condition to temperatures of 430° C. To meet this demand a moderate strength, heat-treatable alloy has been developed. It contains 4% aluminium, with a total of 3% to 4% molybdenum and vanadium combined, this being the basis composition. The heat-treated sheet has been found to be stable under stress of 22 tons per sq in. at 430° C for periods to 1000 hr. The loss in ductility after exposure under stress to elevated temperatures is somewhat greater in the higher strength condition obtained by solution treating at 900° C. but no embrittlement is detected. Total creep deformation of material, solution treated from 840° C and aged at 450° to 540° C, is in the range of 1·1% to 1·4% at 430° C after 1000 hr at 22 tons per sq in. Other interesting results have also been obtained.

A new high strength bronze has been introduced. It is resistant to corrosion, and of high yield and tensile strengths at elevated temperatures. A nickel silicon bronze alloy, it is available in soft, cold forming, and hard, tempers, and can be age-hardened to give maximum strength, hardness and electrical conductivity, by heating at 480° C for 1½ hr. The composition is 97·5% copper, 1·9% nickel, 0·6% silicon.

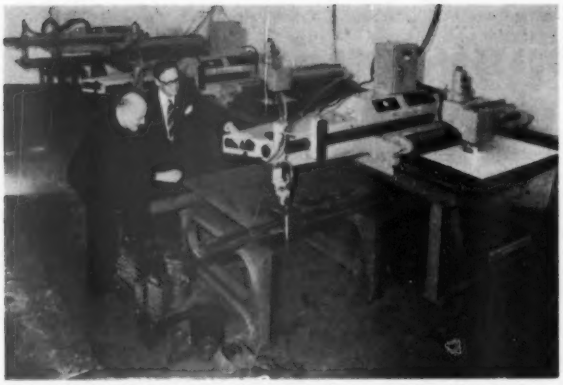
A steel has been introduced which contains typically 0·04% to 0·45% carbon, 1·45% to 1·8% silicon, 0·65% to 0·9% manganese, 1·65% to 2·0% nickel, 0·65% to 0·9% chromium, 0·3% to 0·45% molybdenum, and 0·05% min. vanadium. It is deep-hardening and has also good transverse ductility in heavy sections. In fact, this ductility is exceptional. The steel can be tempered at 310° C and its composition can be modified to give higher strength with acceptable carbon, according to the properties required. For a tensile strength of 130 to 134 tons per sq in., the steel should have not less than 0·4% carbon.

Fully Automatic Scales

The range of A.S.E. fully automatic scales marketed by Shandon Scientific Company Limited, 6 Cromwell Place, London SW7, has been widened to include larger capacity models for industrial purposes. The readability of the A.S.E. scales is achieved by a system of shuttered indicators which enable the pointer to make five revolutions of the dial to cover the instrument's full range equivalent to a reading line of some 13 ft. The graduation divisions are about $\frac{1}{16}$ in. apart, and the scale can easily be read to half a division. On the 2½ kg (5 lb) model, for example, each division represents one gramme ($\frac{1}{16}$ oz) so that it may be read, instantly and accurately, to ½ gramme ($\frac{1}{32}$ oz). Correspondingly close readings are possible on the larger models.

A quick tare device is available on all models, enabling containers weighing up to one-fifth of the instruments' total capacity to be tared instantly, simply by turning a knob. The fitting of this device increases the total scale capacity by one fifth.

Five basic models are available with capacities ranging from 5 lb to 1000 lb.



On test. The first Hancoline production model under appraisal from Mr. E. Seymour-Semper and Mr. L. J. Hancock, managing director and technical director respectively, of Hancock & Co. Limited

Oxygen Profiling Direct from the Drawing

The Hancaline oxygen profiling machine has now reached its production form. It represents a blend of technical ingenuity from both sides of the Atlantic, the electric control system being a development of the Canadian Westinghouse Company and the machine itself a product of Hancock & Co. Limited, the pioneers of the oxygen cutting machine.

The machine offers an ideally simple system for oxygen profiling applicable to the larger part of the steel fabricating industry. The old problem of templates has been reduced to the provision of a simple pencil line drawing of the same dimensions as the finished steel shape required. Basically one can go no further, although machines may be further refined technically as the years go by.

The tracer head incorporates a photocell which vibrates in accordance with the frequency of the electricity supply. This causes the photocell to scan the white areas on either side of the line drawing and this results in a photocell signal at twice line frequency. Any tendency of the machine to wander from the line or any change in direction of the line itself, i.e., a displacement of the line from the centre of vibration, means that two different amounts of light are focused on the photocell in turn. This results in an error signal which is amplified and used to supply the control winding of a servo motor which in turn is geared to the tracer head and in effect steers it directly above the line. The control cabinet measures only 16 in. × 12 in. × 9½ in. and can thus be mounted on the machine itself.

In building this control system into a practical machine Hancock & Co. Limited have added two basic devices of major importance permitting it to be exploited to the full. The first of these is a patented roller drive which enables the machine to operate without physical contact between the tracer head and the drawing.

The second device is one built into the tracer head of the machine. This is an optical device centred around a prism. A calibrated dial is provided which enables compensation for width of cut to be made on the machine itself instead of making drawings of special dimensions. The setting control slightly alters the angle of the prism so that the line of the drawing appears to the photocell to be offset to either one side or the other by an amount corresponding to half the cut width for any given thickness of plate. Thus the finished profiled shapes come out exactly the same size as the pencil drawing.

Earlier versions of this equipment available in the United States but without either roller drive or cut width compensation on the machine itself have received wide publicity and considerable time and cost savings are claimed by the users as against conventional methods using solid templates. The Hancoline cuts times and costs still further and it is not entirely coincidental that Hancock & Company have recently signed long term agreements for the sale of their machines through the Linde Company, Division of Union Carbide, in the United States and Canada.

Electrically Controlled Tube Expander

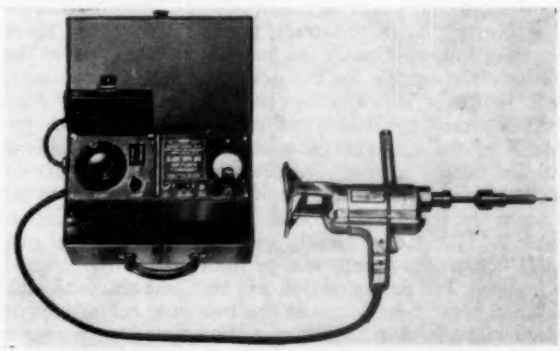
Following upon considerable study of the technique of tube expanding in the manufacture of condensers and heat exchangers, and investigation into electronic devices, Charles Wicksteed and Company Limited, of Kettering, have introduced an automatic unit for the control of tube expansion. Known as the Mark IV it is a compact piece of equipment and incorporates two new patents.

The unit is contained in a steel case, 14 in. × 9 in. × 6 in., and weighs 19 lb. The torque setting control has a separate lockable lid to prevent accidental or unauthorized alteration. The range which can be handled is approximately ⅜ in.–1 in. O.D., but other sizes closely outside this range can be accommodated according to conditions of material, tube sheet thickness and tube wall thickness.

The units are suitable for the dual range of 100/120 volts a.c. or 210/240 volts a.c. 40/60 cycles. A 15 amp supply is adequate. There is an indicator knob and dial for the easy compensation of voltage variation.

The motor is a conventional electric drill type of machine which is automatically reversed by relays on completion of the expanding operation. There is provision for stopping and reversing the motor at any time in case of emergency.

The standard equipment includes a voltmeter, voltage variation adjustment, mains warning light, voltage range selector plugs, spare fuses, lengths of cable and plug, expander motor, and one adjustable ball bearing thrust type of expander with spares and three sizes of coupling adaptor.



Wicksteed Mark IV automatic tube expander and control unit

Nuclear Marine Propulsion in Russia, France and Japan

Some Russian and French projects were dealt with in our December, 1959, issue. Here the author concludes his survey, and deals with Japanese nuclear marine plants.

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

C. Japan

In 1954 the Japanese Government established a Preparatory Council on the Peaceful Uses of Atomic Energy. At the end of 1955 it was dissolved and on January 1, 1956, the Atomic Energy Commission was formed to administer nuclear research and development. At the same time the Atomic Energy Bureau was set up as an executive agency to be responsible for conducting the general administration of atomic energy development.

On May 4, 1956, the Atomic Energy Research Institute was created. The building was commenced in August, 1956, at the village Tokai-Mura, about 70 miles north-east of Tokyo. The primary object of AERI is to devote its activities to the construction and the operation of experimental reactors, to basic and applied research and to the training of nuclear scientists and engineers. The initial research equipment consisted of two experimental reactors, one of the boiling light water- and the other of the heavy water-moderated type. Both have been purchased from the United States. In addition a natural uranium heavy water reactor has been constructed with local materials as far as possible. The Isotope Centre was started in 1956 and the National Institute of Radiology in 1957. Thirty-five persons were sent to Britain and to the United States in 1956 for intensive training in nuclear science and technology.

During 1956 the Japanese commenced discussions with Britain and at the same time with the United States on the purchase of a reactor for a nuclear power station. After three years of negotiation the contract was placed in Britain with the G.E.C.-Simon-Carves Atomic Energy Group. The two British groups that were competing are A.E.I.-John Thompson Nuclear Energy Company Limited and the English Electric-Babcock and Wilcox-Taylor Woodrow Groups. The United States companies proposed a pressurized light water-moderated and cooled reactor whilst the British groups quoted for a graphite-moderated and gas-cooled unit of the Calder Hall type.

According to the contract, the G.E.C.-Simon-Carves Atomic Energy Group, as main contractor, is to be entirely responsible for the design of the complete project. However, it is specified that certain parts are to be manufactured by Japanese firms in the group's design. Much of the manufacture and the construction will be carried out by a newly formed consortium of fourteen well-established Japanese engineering companies, to be known as the First Atomic Power Industrial Group (F.A.P.I.G.). Consequently only a proportion of the total construction cost will be allocated to the United Kingdom. The power station will have one reactor of the same general dimensions as the two now being built at Hunterston in Ayrshire. It may, however, incorporate a number of more up-to-date design features, for instance, a new type of fuel rod consisting of a hollow cylinder. A most important characteristic requirement of this reactor is that it should prove resistant to earthquakes.

On November 20, 1958, The Fuji Electric Company of Japan announced that it had concluded a contract with the General Electric Company Limited, of England, for technical co-operation on nuclear power generation. The Fuji Electrical Company belongs to a Japanese nuclear industrial group. The terms of this licence agreement are that Fuji Electric Company is to pay between £140,000 and £180,000 and in addition royalties of 4% to the G.E.C. and about 3% to the United Kingdom Atomic Energy Authority. Consequently, Japan is now able to proceed with the development of nuclear power on a royalty basis and to build reactors for a net electrical output of 400 MW.

Nuclear power will be of major importance to Japan for the fossil fuel deposits there are relatively small, industries are developing at a tremendous rate, the population is increasing fairly rapidly and there are indications that the standard of living is improving. Therefore it is not surprising to find that the Japanese Atomic Energy Commission has prepared a long-term plan for the development of nuclear power both on land and sea. There are several areas which have uranium deposits and others are being thoroughly explored. Within the next two decades the domestic supplies are not expected to meet more than about 6% of the requirements. The nuclear programme includes four research reactors and a generating capacity of 600 MW from nuclear power by 1965 and 7000 MW by 1975. Also a 10 to 15 MW enriched uranium water cooled reactor is to be built and then thermal and fast reactors, each of 1 to 10 MW. It is expected that a 100 MW breeder reactor will be designed and constructed at a later date, using only Japanese manpower.

The uranium refining plant, which was started on December 18, 1958, has now been completed by the Atomic Fuel Corporation. On March 24, 1959, a technical assistance agreement was signed between the Japan Atomic Electric Power Company and the United Kingdom Atomic Energy Authority. It is reported that a new Japanese atomic energy group has been formed, consisting of the following companies: Meidensha, C. Itoh and Company, Yamatake-Honeywell, Nippei Industries and Japan Carbon.

The Japan Atomic Electric Power Company is made up of private industry, the nine large power companies and the Japanese Government. A nuclear group based on the Tokyo Electric Express Railway has been proposed with the object of importing a reactor, possibly, from General Dynamics Corporation.

The above introduction indicates clearly that Japan is determined to be in the forefront of developing nuclear power by applying wisely foreign resources in research, design, construction and in operating experience on nuclear power plant. This is indicated sufficiently clearly by their ambitious long-term programme. Undoubtedly Japan's serious approach in planning such major projects must be admired.

It is now proposed to present briefly certain information on Japan's first nuclear power station and finally detailed particulars resulting from specific design studies on the application of nuclear power plant to the propulsion of surface vessels and submarines.

1. Japan's first nuclear power station

As already mentioned in the introduction the Japan Atomic Electric Power Company has placed a contract with the G.E.C.-Simon-Carves Atomic Energy Group for the supply of plant for the first nuclear power station to be located at the village of Tokai-Mura, close to the newly built Atomic Energy Research Institute, which is 70 miles north-east of Tokyo. The approximate value of the group's contract is reported to be £20 millions, which corresponds to £133 per net kW. The work on site is to commence towards the end of 1959 and the station is to be in operation in 1963. The station is designed to give a net electrical output of 150 MW. The plant consists mainly of one graphite-moderated and gas-cooled reactor, designed for a thermal rating of about 500 MW, four heat exchangers, four CO_2 circulators, a pressure vessel and two main turbines, each having a maximum continuous capacity of 85 MW. Additional particulars are indicated in Table VIII. The turbines are of the single shaft, dual pressure type. The plant will be similar to that installed at the C.E.G.B.'s fourth nuclear power station at Hunterston, Ayrshire. A summary of the essential particulars and the principal design data of this station is presented in February, March and April issues of this Journal. On examining the information contained in these tables one finds that Hunterston has two reactors, each with a thermal rating of 530 MW and the total net electrical is 320 MW, or 160 MW per reactor, which is only slightly higher than that for Tokai-Mura. However, there are to be certain modifications to the structure and the control of the reactor to allow for Japanese conditions. The inside diameter of the spherical pressure vessel is 62 ft. Each heat exchanger has an inside diameter of 21·5 ft and a height of 84 ft.

The nuclear fuel for this power station is to be bought outright by the Japan Atomic Electric Power Company under a loan provided by a British finance company, repayment being made from a charge on the running costs. It is understood that the cost of the fissile material will be approximately £21,000 per tonne.

Table VIII.—JAPAN'S FIRST NUCLEAR POWER STATION AT TOKAI-MURA

1	2	3	4
1.	Reactors		1
2.	Heat rating of reactor	MW(H)	500
3.	Number of fuel channels		2056
4.	Number of fuel elements per channel		8
5.	Total number of fuel elements		16,448
6.	Total generating capacity (gross)	MW(E)	170
7.	Total net electricity capacity	MW(E)	150
8.	Total number of main turbines		2
9.	Maximum rating of each main turbine	MW(E)	85
10.	Number of heat exchangers		4
11.	Number of circulators		4
12.	Type of circulator: vertical, single stage, radial flow		
13.	Shape of pressure vessel		sphere
14.	Diameter of the pressure vessel (inside)	ft	62
15.	Thickness of biological shield	ft	10
16.	Inside diameter of each heat exchanger	ft	21·5
17.	Height of each heat exchanger	ft	84

2. Nuclear marine propulsion

Although this contribution is mainly concerned with nuclear marine propulsion it was considered advisable to review first of all Japan's nuclear power programme, as indicated above, and then to direct attention to specific preliminary proposals, applicable to the propulsion of surface vessels and submarines, investigated by the Japanese. In terms of gross tonnage of vessels launched, Japan is placed first among the world's shipbuilding nations. This is based on the statistics issued by Lloyd's Register of Shipping.

2.1. Nuclear-powered submarine tanker

At the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, a Japanese paper on the above subject was presented by Michiya Shigemitsu, manager of the Ship Designing Department of Kobe Shipyard and Engine Works. The fundamental significance of a nuclear-powered submarine tanker is that the performance is improved as a result of the reduction in surface resistance when cruising under water. In addition, it permits an increase in deadweight and the power for propulsion. The primary advantages of a submarine tanker are:

(a) The wave-making resistance of a surface vessel becomes far more pronounced with increased speed, whilst submarines are not affected.

(b) From the point of view of resistance there is a range of speeds where submarines are more advantageous than surface vessels.

(c) A comparison made for 30,000 to 40,000 tons d.w. tankers revealed that the resistance curves for submarines and existing shapes of surface vessels cross at a speed of 19 knots. At above that speed the submarine becomes advantageous.

(d) In a submarine, the size of pressure hull is relatively small, for the greater part consists of non-pressure resisting tank spaces.

(e) A saving in the weight of the hull construction of 10% could be achieved at proper submergible depth.

Table IX.—ESSENTIAL DESIGN DATA OF NUCLEAR POWERED CARGO SUBMARINE PROPOSED BY MITSUBISHI'S KOBE SHIPYARD

1	2	3	4
1.	Type of reactor: Pressurized light water-moderated and cooled (P.W.R.)		
2.	Reactors		1
3.	Heat rating of reactor	MW(H)	150
4.	Fissile material: Pellets of uranium dioxide (UO_2)		
5.	Enrichment of fissile material	%	1·7
6.	Total weight of the fissile material	tonne	7·270
7.	Mean fuel rating	MW/tonne	20·64
8.	No. of fuel assemblies		88
9.	No. of cruciform cadmium silver control rods		17
10.	Material of the fuel rod cladding		zircaloy
11.	Burn-up	MWD/tonne UO_2	9200
12.	Period for refuelling	hr	10,000
13.	No. of years in operation at full load	yr	2
14.	Primary coolant: inlet temperature	°F	536
	outlet temperature	°F	500
	drop in temperature	°F	36
15.	No. of heat exchangers		2
16.	Type of heat exchanger: vertical and tubes		
17.	Steam conditions: pressure	psi	566
	temperature	°F	482
18.	No. of cross compound steam turbines		2
19.	Power of each turbine	shp	22,000
20.	Total power	shp	44,000
21.	Length of vessel	ft	590
22.	Displacement	ton	48,200
23.	Weight of oil cargo	ton	30,000
24.	Cruising speed submerged	kn	22
25.	Safe operating depth	ft	328

The essential design data of the nuclear-powered cargo submarine proposed by Mitsubishi's Kobe Shipyard is summarized in Table IX. This submarine is 590 ft long, has a displacement of 48,200 tons, and will carry 30,000 tons of oil at a cruising speed of 22 knots when submerged. Her safe operating depth is 328 ft and the total power of the two cross-compound steam turbines is 44,000 shp. The reactor selected is of pressurized light water-moderated and cooled type, its heat rating being 150 MW (H). The fissile material is 1·7% enriched uranium dioxide pellets and weighs 7·27 tonnes. The period for refuelling is 10,000 hr, which corresponds to two years' operation at full load. The mean fuel rating is 20·64 MW/tonne and the burn-up 9200 MWD/tonne UO_2. The steam conditions are 566 psi and 482°F.

The hull of the submarine is streamlined, and sail, stabilizing fins and diving planes are provided for stability and manoeuvring. The hull is of double construction with a cylindrical pressure part in the centre and surrounded by non-pressure parts. The reactor, the two heat exchangers, the control and engine rooms and the living quarters are arranged in the pressure-resistant hull. In the outer non-pressure part cargo oil tanks and ballast tanks are provided.

2.2 Nuclear-powered emigrant ship

Facilities for emigration are to be provided to solve the population problem in Japan. However, the number of emigrants is extremely small in relation to the total population. The Japanese Government's estimate for the year commencing on April 1, 1956, was 7000. Present day transportation capacity restricts the number to about 5000 per year. Therefore the government has decided to proceed with the construction of additional ships, specially built to carry emigrants. Japan's poor energy resources has compelled her to rely entirely on oil imported from abroad. The total tonnage at the end of 1957 was 4,500,000. The crude oil consumption per year for transporting emigrants to South and Central America is about 4,000,000 tons. The present Japanese merchant fleet has only five ships fully equipped for this service. These are all operated by the Osaka Shosen Kaisha (O.S.K. Line). Such a one-way voyage took over 40 days. In order to improve on this performance and the operating costs the O.S.K. Line proposed that the possibility of a nuclear-powered emigrant ship should be thoroughly explored. The results of this special design study and analysis of the costs were presented in a paper submitted to the Second United Nations International Conference on the Peaceful Uses of Atomic Energy (Paper A/CONF.15/P1319). It concerns a joint project of Mitsubishi Heavy Industries Reorganized Limited and Ishikawajima Heavy Industries Company.

The detailed particulars of the vessel are indicated in Table X, a summary of the technical data on the pressurized light water-moderated and cooled reactor is presented in Table XI, the performance data of the heat exchangers are shown in Table XII and, finally, the particulars of the main propulsion in Table XIII. The vessel has an overall length of 672 ft 5 in., a full displacement of 26,380 tonnes, a maximum power of 44,000 shp at 160 rpm. She carries 2500 passengers and crew of 232, therefore a grand total of 2732. The tip diameter of the propeller blades is 17 ft 4½ in.

Table X.—NUCLEAR POWERED EMIGRANT SHIP (JAPAN)

1.	Dimensions:	
	(a) overall length	672 ft 5 in.
	(b) breadth	84 ft 0 in.
	(c) depth	45 ft 7 in.
	(d) draught	29 ft 2in.
2.	Tonnage and capacity:	
	(a) gross	20,100 tonne
	(b) full load displacement	26,380 tonne
	(c) dead-weight	9100 tonne
	(d) weight of hull only (b-c)	17,280 tonne
	(e) weight of complete machinery	4400 tonne
	(f) cargo capacity	388,410 cu ft
3.	Power and speed:	
	(a) normal power	40,000 shp
	(b) max. power	44,000 shp
	(c) normal propeller speed	150 rpm
	(d) max. propeller speed	160 rpm
	(e) service speed of vessel	23·5 knot
	(f) max. speed of vessel	25·0 knot
	(g) No. of propellers	2
	(h) No. of blades per propeller	5
	(i) tip diameter of blades	17 ft 4½ in.
4.	Accommodation:	
	(a) cabin class	40
	(b) tourist class	160
	(c) third class	2300
	(d) total passengers	2500
	(e) number of crew	232
	(f) grand total	2732

Table XI.—PRESSURIZED LIGHT WATER-MODERATED AND COOLED REACTOR FOR A NUCLEAR POWERED EMIGRANT SHIP OF 44,000 SHP

1.	Heat rating of reactor	180 MW(H)
2.	Fissile material	uranium dioxide
3.	Initial enrichment	1·7%
4.	Final enrichment	0·9%
5.	Weight of fissile material	8·25 tonne
6.	Total No. of fuel assemblers	88
7.	Fuel units per assembly	3
8.	No. of rods per fuel unit	100
9.	Total No. of fuel rods	26,400
10.	Outside diameter of fuel rods	0·4035 in.
11.	Thickness of cans for UO_2 pellets	0·0236 in.
12.	Diameter of pellet	0·3543 in.
13.	Height of pellet	0·3543 in.
14.	Spacing of fuel rods	0·5118 in.
15.	Length of fuel rod	19·094 in.
16.	Diameter of core	62·992 in.
17.	Height of core	59·055 in.
18.	Burn-up	9200 MWD/tonne UO_2
19.	Life of core	10,000 hr
20.	Plutonium production	87·3 lb
21.	Pressure of coolant (light water)	1991 psi
22.	Pressure drop of coolant across core	22·37 psi
23.	Total pressure drop of coolant	72·10 psi
24.	Total flow of coolant	240,142 cu ft/hr
25.	Velocity of coolant along fuel rod	15·7 ft/sec
26.	Temperature of coolant at inlet to reactor	498·2° F
27.	Temperature of coolant at outlet from reactor	537·8° F
28.	Average temperature of coolant	518·0 °F
29.	Temperature rise of coolant	39·6° F
30.	Maximum fuel temperature at centre	2714° F
31.	Weight of zircaloy	6·3 tonne
32.	No. of cruciform control rods	17
33.	No. of primary loops	2
34.	No. of heat exchangers	2

Table XII.—PERFORMANCE DATA OF HEAT EXCHANGERS FOR NUCLEAR POWERED EMIGRANT SHIP OF 44,000 SHP

1.	No. of heat exchangers	2
2.	Type	vertical, shell and tubes
3.	Evaporation of each heat exchanger	264,480 lb/hr
4.	Total evaporation	528,960 lb/hr
5.	Steam pressure at outlet from heat exchangers	563 psi
6.	Steam temperature at outlet from heat exchangers	482° F
7.	Temperature of feed water	302° F
8.	Heating surface of each heat exchanger	11,625 sq ft
9.	Total heating surface	23,250 sq ft
10.	Steam produced per sq ft of heating surface	22·75 lb/sq ft
11.	Primary coolant temperature at inlet to heat exchanger	537·8° F
12.	Primary coolant temperature at outlet from heat exchanger	498·2° F
13.	Temperature drop of primary coolant	39·6° F

Table XIII.—MAIN PROPULSION PLANT FOR A NUCLEAR POWERED EMIGRANT SHIP OF 44,000 SHP

1.	Cross compound double reduction geared turbines	
2.	No. of sets	2
3.	Normal rating of each set	20,000 shp
4.	Maximum rating of each set	22,000 shp
5.	Total normal rating (both sets)	40,000 shp
6.	Total maximum rating (both sets)	44,000 shp
7.	Normal speed of propellers	150 rpm
8.	Maximum speed of propellers	160 rpm
9.	Steam pressure at stop valve of H.P. turbines	526 psi
10.	Steam temperature at stop valve	472° F
11.	Vacuum at L.P. turbine exhaust (30 in. Hg bar)	28·5 in. Hg
12.	Type of condenser	radial flow single pass
13.	No. of condensers	2
14.	Surface of each condenser	21,528 sq ft
15.	No. of feed heating stages	3
16.	Weight of complete main turbines and condensing plants	460 tonne

The heat rating of the reactor is 180 MW(H). The fuel is uranium dioxide enriched intially to 1·7% and finally to 0·9% and weight is 8·25 tonnes. Therefore the mean fuel rating is 21·82 MW per tonne UO_2. This value agrees very closely with 20·64 MW per tonne UO_2 for the nuclear-powered cargo submarine proposed by Mitsubishi's Kobe Shipyard the enrichment being the same. The burn-up for the emigrant ship is 9200 MWD/tonne UO_2 and for the cargo submarine it is the same. The refuelling period for both vessels is 10,000 hr. Also the maximum shaft horse powers are equal. This applies to the number (two) of heat exchangers. The containment vessel installed in the emigrant ship is, designed for 170 psi. Its inner surface will be lined partly with lead to reduce radiation intensity. The interior is ventilated and the contaminated air is discharged through a filter to atmosphere.

There are three turbine driven auxiliary generators, each rated at 2000 kW, of which only two are in constant use. The steam from each turbine passes to its auxiliary condenser. In addition there is a diesel generator of 400 kW for emergency supply. A special feature is the 2000 hp four cylinder, vertical emergency diesel engine. It is coupled to the starboard intermediate shaft through reduction gearing and a clutch. When operating under emergency conditions the shaft coupling is disconnected so as not to rotate the main turbine.

The overall performance of this proposed ship has been examined and the conclusions are summarized briefly below. The route considered for this analysis is: Kobe–Belem (Brazil)–Santos (Brazil)–Buenos Aires (Argentina)–Santos–San Francisco–Kobe, using the Panama Canal for both west and east bound voyages. The distance covered will be 29,300 nautical miles. It is estimated that with 52 days navigation and 12·5 days in port the total time is 64·5 days for a single voyage. Allowing for a reserve of 2·5 days, the entire route takes 67 days. Assuming 30 non-operational days it is possible to do five such voyages per annum. Also there is a saving of 2,900 sea miles compared with the traditional route, which was specially arranged for making calls for oil supplies. Consequently, this nuclear-powered vessel enables a saving to be made per voyage of 31 days at sea and 22 in port, therefore two extra voyages can be made per year. Thus it is possible to transport 12,500 passengers with such a vessel. The construction cost is equivalent to $24,166,000 (£8,800,000) which includes:

(a) hull and outfit
(b) propulsion plant, main and auxiliary generators and the electrical equipment
(c) reactor plant (excluding the fabrication of the core and the initial fissile material)
(d) installation, planning and the design.

The initial uranium and the fabrication of core amount to $2,622,000 (£955,000). Therefore the total cost is $26,788,000 (£9,755,000).

2.3. Japan's first nuclear-powered merchant ship

The Japanese Atomic Industrial Forum have indicated that this will be an experimental vessel of 3000 tons, designed for a speed of 19 knots. A pressurized light water-moderated and cooled reactor containing a core fuelled with 2640 lb of enriched uranium, produces the steam for two 4000 hp turbines. The estimated cost of the ship is £3 million, which includes about £2 million for the reactor.

2.4. Japan's nuclear-powered oil tanker

Plans have been made for a 40,600 ton atomic tanker to operate between Japan and Persia. She would have a pressurized light water-moderated and cooled reactor, designed to supply a power of 25,000 shp. Her oil carrying capacity is to be 65,000 tons.

Worm Drive Mining Hydraulic Pump

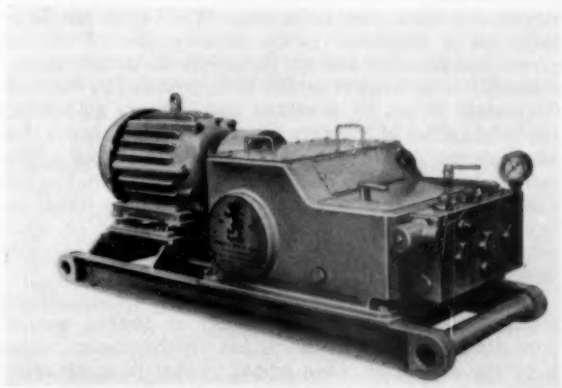
For several years, since the inception of coal face mechanization involving the use of hydraulic power, Joseph Evans & Sons (Wolverhampton) Limited, Culwell Works, Wolverhampton, have supplied considerable numbers of hydraulic pumps. The pump is the heart of any hydraulic system and the success of the installation depends upon the complete reliability of the pump unit. Their latest design is specifically developed as a mining hydraulic pump and incorporates many features which are the result of long experience in mining duties.

The pump is of the 1¼ in. × 2 in. horizontal triplex plunger type, capable of delivering 5 or 7·5 gpm against pressures up to 1500 psi, depending upon motor horse power and speed. It will handle water, water/soluble oil mixture or hydraulic oil. The crankcase is of fabricated steel construction and fully stress relieved. It is totally enclosed with a positive lubrication system and a special breather ensures that dust and condensate cannot enter the crankcase. The worm drive is inside the crankcase and the crankshaft and worm shaft run in ball/roller bearings. Renewable crosshead guides are provided.

The pump block is of forged steel with hard bronze valves and renewable seats, and nitralloy pump plungers, and the cast steel stuffing boxes have self expanding V-type gland packings. All wearing parts are easily renewable and special attention in the design has been paid to accessibility.

A fully flexible coupling is fitted with a heavy gauge guard. The pump will operate equally well in either direction of rotation, and a slight deviation from the horizontal will not affect the efficiency of the lubricating system.

A skid type steel baseplate accommodates pump and motor. The overall width is only 22 in.



This latest design horizontal triplex plunger type pump will deliver 5 or 7·5 gpm against pressures up to 1,500 psi

Control of Radioactive Wastes

IN order to ensure that the widening use of radioactive materials does not expose the public to dangerous amounts of radioactivity the Government has decided to extend and unify the controls over the discharge of radioactive wastes. Hitherto, and apart from the arrangements applying to the Atomic Energy Authority, risks to public health have been avoided principally through co-operative arrangements between central and local government. But on the advice of an expert panel the Government proposes to revise the system. The Radioactive Substances Bill provides that:

(1) Temporary controls (which bring under the control of the Minister of Housing and Local Government and the Minister of Agriculture, Fisheries and Food —in Scotland, the Secretary of State—any discharge of radioactive wastes by the Atomic Energy Authority and other licensed nuclear installations) will be made permanent.

(2) Other users of radioactive materials will be obliged to register their premises with the appropriate Minister (in England and Wales the Minister of Housing and Local Government, and in Scotland the Secretary of State).

(3) No disposal of radioactive wastes will be permitted except on an authorization from the appropriate Minister or Ministers.

(4) The Minister of Housing and Local Government and the Secretary of State for Scotland will, in addition, have power to arrange a national disposal service to handle wastes which cannot safely be dealt with in the areas in which they originate.

Why the bill is necessary

The Government's action follows the report of an expert panel appointed at the request of the Minister of Housing and Local Government by the Radioactive Substances Advisory Committee. The report appears as an appendix to the explanatory White Paper "The Control of Radioactive Wastes" (Cmd. No. 884, H.M. Stationery Office, Price 2/6d. net).

The panel recommended central control because, apart from special provisions which apply to the Atomic Energy Authority, existing controls governing disposal of radioactive wastes are the same as those governing ordinary wastes. None was specifically designed to cope with radioactive wastes, and some can be applied only when harm has started to be done. While some release of radiation is inevitable in the development of nuclear power and research and the industrial use of radioactive materials, wastes can generally be disposed of by methods commonly in use by sewerage and sanitary authorities for the disposal of ordinary wastes, provided always that adequate precautions are taken. Local disposal of wastes can safely continue in many instances, thus avoiding the risk of increased exposure through multiple handling. Where local disposal in not prudent the use of other methods, e.g., dumping at sea or burial at specially selected sites is indicated.

In the words used in the White Paper, "In considering whether a given discharge should or should not be permitted, it is necessary to decide whether the radiation from the discharge, when added to that from all other sources of radiation, is likely to result in a genetic hazard to the nation as a whole; from this point of view it is as much the concern of, for example, London as of Manchester if the inhabitants of either are exposed to ionizing radiations." This is the case for central government supervision of the methods of disposal.

The White Paper says that hitherto concentrations of radioactivity in wastes such as might involve risk to public health have been effectively avoided by administrative action. The Government have accepted the panel's recommendations in principle. The new Bill gives effect to them, and replaces certain powers now held by local bodies. It provides in appropriate cases for consultation with and supply of information to local authorities on the whereabouts of radioactive materials and on methods of disposal. The reason for having a register of users of radioactive materials (other than A.E.A. and licensed nuclear installations) is to impose a control at source. Registration in itself is not an authorization to dispose; each undertaking, once registered, must submit its proposals for disposing of radioactive waste and get them authorized.

Steam Raising Units at Hinkley Point

Work is now well advanced at Hinkley Point on the site prefabrication of the 67 ft dia, 3 in.-walled pressure vessel for No. 1 reactor and on the 90 ft high × 21 ft 6 in. dia shells of the steam-raising units.

The sub-assemblies for the shells of the steam-raising units are fabricated by fusion-welding at the Dalmuir works of Babcock and Wilcox Limited and shipped to site via Combwich. When welding on site is completed, the weld surface is prepared for examination and the joint X-rayed by a 250 kV mobile industrial X-ray unit, Type TF 1555B, supplied by Marconi Instruments Limited.

After stress-relieving, hydraulic testing and sealing, each completed shell, weighing some 385 tons, is ready for placing in position on its prepared foundations, there being six steam-raising units per reactor, placed three each side of the reactor building. The S.R.U. internals will be installed subsequently, under the strictest "clean-room conditions", the complete units having each a weight of some 1,250 tons.

The steel plates for the spherical pressure-vessel are formed at the Renfrew works of Babcock and Wilcox Limited, each course of plates being pre-assembled on jigs to check shape and alignment. Groups of several plates are fully welded at the works into assemblies suitable for transport to site. The plate assemblies as received from the works are built into complete circumferential courses in the site pre-fabrication shop. The joints between them are then manually welded, following which a thorough X-ray inspection is carried out.

The Marconi X-ray apparatus is of the constant potential type and the basic equipment comprises four main items—high tension transformer-rectifier unit, control unit, oil-cooled tubehead, and an oil circulator/cooler unit. A mobile trailer, which is towed into position on site, accommodates the complete apparatus, including the control unit. The equipment is fitted with an extended lift and a taller than normal tube column, providing a wide range of movements, essential for X-ray inspection of large units of this kind.

Reactor Alignment and Fuel-charge Handling

In the construction of the nuclear reactor, provision must be made for precise placement of the uranium (or other fissile material) fuel rods and graphite moderators. Upon this precision depends the safe and efficient working of the reactor.

It is achieved by locating a series of guide-holes in the reactor-chamber roof with a corresponding system of orifices in the chamber floor. By aligning to very close tolerance both sets of holes, fuel and moderating rods can be placed—throughout their length—in the mathematically correct positions.

The Taylor-Hobson "Micro" alignment telescope is used for the precision correlation of upper and lower systems, between which there is a vertical distance extending in some case to one hundred feet. The telescope locates each hole to the very close tolerances laid down for each stage of construction, correctly channeling fuel and moderating rods, and ensuring the overall accuracy specified by the C.E.G.B.

Nuclear reactors and projects in which Taylor-Hobson instruments have played important parts are the U.K. Atomic Engineering Research Establishment's ZETA, BEPO, ZEUS, ZEPHYR, DIDO and PLUTO; and Berkeley, Hunterston and Hinkley Point.

The replenishment of the reactor chamber with fresh fuel rods, in the Nuclear Power Plant Company's installations, is by means of a 400-ton charge machine which conveys the rods to, and into, the system of guide-holes. The machine also withdraws the spent rods from the reactor, for inspection and disposal.

It is impossible for technicians to approach the fiercely-radiating fuel rods so the inspection must be carried out from a remote and protected position. To enable this to be done, three Taylor-Hobson periscopes are installed in each charge machine—one of them connected with a closed-circuit television camera. These show the operator the exact state of the fuel rod, and checks that the rod has been successfully withdrawn. To nullify the effect of radiation on the inner end of the periscope, the window and intermediary lenses are of "stabilized" glass.

Nuclear power stations to be equipped with Taylor-Hobson instruments are Bradwell and the Italian Latina plant, for both of which the fuel-inspection periscopes are being supplied to the main contractors, Nuclear Power Plant Company Limited, through Messrs. Strachan & Henshaw Limited.

Dounreay's "Hot" Laboratory

One of the world's most elaborate "hot" radioactivity laboratories is a vital feature of the new fast breeder reactor at Dounreay, Caithness. No similar reactor has ever operated before and, because of its unusual features, it is essential for nuclear scientists to carry out laboratory examination of intensely radioactive fuel elements.

Everything in the laboratory is done by remote control, using closed-circuit television and protective windows. Engineers and scientists operate the complicated equipment from behind concrete walls. Master slave manipulators follow precisely the movements of an operator's fingers and are sufficiently sensitive to pick up a pin.

The laboratory at Dounreay is in the form of a U-shaped cave, divided into "cells" covering a large floor area. Its design and supply was the responsibility of the Pye Atomics Division and specialists from Pye worked in collaboration with engineers of the Industrial Division of the United Kingdom Atomic Energy Authority at Risley, Lancashire.

The radioactive fuel element from the reactor arrives at the laboratory in lead "coffins" to contain its radioactivity and is lowered into the cave. From the moment the fuel element arrives in the cave remotely-controlled mechanisms take charge and a score or more processes are necessary to examine it. The element is measured and carefully studied to find the changes which have taken place while it was heating in the reactor.

Dual Reactor Power Plant

Two pressurized water reactors of the land based prototype nuclear power plant for large surface ships have operated in parallel at full power at Idaho Falls, U.S.A. The plant, known as the A1W prototype, is the United States' first nuclear power plant to have two reactors powering one propeller shaft. Designed as the forerunner of the power plants for two United States Navy combatant ships now under construction, the guided missile cruiser, *Long Beach*, and the aircraft carrier, *Enterprise*, the A1W is the largest naval nuclear power plant in operation.

The A1W prototype power plant was designed and developed by Westinghouse Electric Corporation at the Atomic Energy Commission's Bettis laboratory, Pittsburgh, under the direction of and in technical co-operation with the Naval Reactors Branch of the AEC. Westinghouse operates the Bettis laboratory for the Commission.

Burst Slug Detection Equipment

After considering several burst slug detection schemes for the new advanced gas-cooled reactor under construction at Windscale, the United Kingdom Atomic Energy Authority has chosen that submitted by Plessey Nucleonics Limited. The system is based upon a square matrix arrangement of the fuel sampling pipes in that 16 *x* co-ordinate detectors and 16 *y* co-ordinate detectors are employed to give continuous monitoring of the 253 fuel channels, without sequential gas sampling. Eight detector units are housed in one pressure vessel, so that a total of four such assemblies is required for the complete installation. Output signals from each detector are processed by transistorized ratemeters, using printed circuits, and the data is displayed in the control room by means of four eight-point recorders of conventional design.

Low-level Beta Counting

A new Philips low-level beta counting arrangement (PW.4127) is designed to measure low specific activities of radioactive materials: it has an extremely low background count of 1·5 per min. Special features include a new type of guard counter, a sample counter with an extremely thin window (1·5 mg/cm^2), motorized sample drive and low specific activity lead shielding. It is suitable for many applications including C14 dating, tracer work, measurement of effluents, milk, foodstuffs. It is supplied by Research and Control Instruments Limited, Instrument House, 207 King's Cross Road, WC1.

Spark Machining

Speedy production of large die blocks

The rapid spark machining of forging die blocks up to 28 in. × 16 in. × 15 in. deep and without manual attention becomes possible with the advent of a new Erodomatic machine developed by Wickman Limited, of Coventry. The equipment is designed as three units; the machine tool, generator, and dielectric fluid circulator, each being capable of disposition according to the shop layout. The units are of uniform width and particularly suitable for in-line arrangement as shown in Fig. 1.

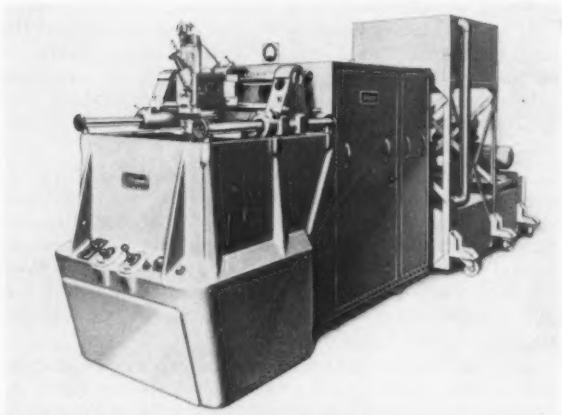


Fig. 1.—The Wickman Erodomatic Type W/BM, showing arrangement of generator and dielectric tanks

The main body is a light alloy casting, the upper part forming the work-tank within which is mounted the work-table measuring 32 in. × 20 in. Circular rails mounted transversely on the work-tank carry a cross rail on which is the servo head unit. The cross rail has a worm and segment to enable the servo head unit to be pivoted into the horizontal position as shown in Fig. 2. Thus the servo head unit can be quickly moved to its furthermost backward position completely clear of the work-tank area to provide unimpeded access to the work-tank and to enable heavy die-blocks to be loaded and unloaded by overhead lifting facilities.

The transverse and longitudinal travel of the servo head covers 28 in. × 16 in. and the transverse cross rail carriage and the servo head can be precisely located in one-inch increments; a compound slide arrangement fitted to the servo head provides fine adjustment on both rectangular co-ordinates in increments of 0·001 in. The upward pivotal movement of the servo head also facilitates the fitting and inspection of electrodes.

With the exception of a cartridge-fused main isolating switch mounted in the rear of the electrical unit, and the water stop cock, operating controls are brought to a

Fig. 2.—The tool head may be pivoted as shown to facilitate the fitting of electrodes, or for inspecting purposes during machining without disturbing location

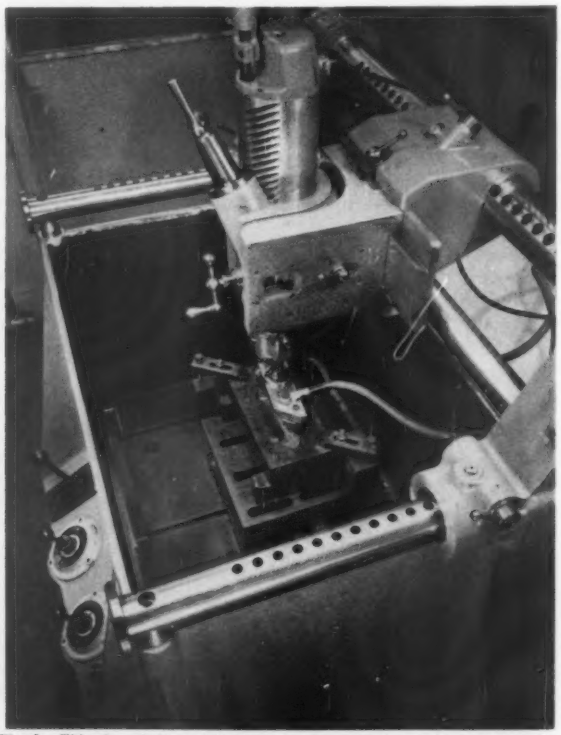


Fig. 3.—This view of the tool head carrier shows the degree of coverage to the toolhead provided by its adjustment along the transverse and longitudinal rails. The tool head incorporates slides for precise location

PERFORMANCE DATA

Model	Range 1			Range 2			Range 3		
	Frequency	Loading	Metal Removal rate	Frequency	Loading	Metal Removal rate	Frequency	Loading	Metal Removal rate
	(cps)	kw	cu mm/min	(cps)	kw	cu mm/min	cps	kw	cu mm/min
Erodomatic W/DM (4·5)	100 Controlled	4·5	400	Random	3·0	150	Random	2·0	100
Erodomatic W/DM (13·0)	600 Controlled	12·0	1,000	600 Controlled	4·0	300	Random	2·0	100

Electrical supply = 400/440 volts 3 phase 50 cycles.
Size of work-piece (maximum) 28 in. × 16 in. × 15 in. deep.
Overall width of unit 3 ft 6 in.
Work-table size 32 in. × 20 in.
Filling time for tank 70 sec.
Manual adjustment (vertical) of servo head 6 in.
Automatic quill stroke 3 in.
Maximum permissible electrode assembly weight 20 lb.

sloping panel on the front of the machine. The panel carries the following "on" and "off" push buttons, a three-position cutting range selector, the lever operated "work-tank fill" cock, a two-position switch for quill—"fast up" and "fast down", a servo adjusting control, and an amber light warning "mains on", a duplicate of which is on the cubicle.

The work-tank has a float switch controlling the generator and servo-control system which ensures that cutting power cannot be delivered to the electrode until the work-piece is properly immersed in dielectric fluid, and thus removes risk of fire or danger to the operator from electric shock.

Operation of the equipment is virtually automatic once setting up has been completed and it requires merely the actuation of the "fill" cock to start machining, which continues until the depth of impression has been reached and the trip switch shuts off cutting power. Operation of the "drain" cock at any time for inspection or other purpose will also shut off cutting power. An overflow weir is provided at the upper fluid level in the work-tank capable of taking the maximum delivery. The rate of flow to the tank is adjustable.

The work-table is positively located within the work-tank, but can be lifted vertically if required. Spare work-tables can be used to enable work-pieces to be set-up independently. The table is not clamped down but is held by its own weight by a patented system.

The servo-controlled tool head is in the form of a self-contained cartridge element and can be adjusted manually through 6 in. vertically to provide for differing thicknesses of work-piece. It also has a 3 in. automatic quill stroke driven by reduction gearing from a servo-controlled special electric motor built into the machine; and is capable of operating a maximum weight of electrode tool of 20 lb. In order to secure minimum reaction time and thus efficient operation, the design is such as to reduce both electrical and mechanical inertia as far as possible.

A graduated scale on the head with cursor on the moving quill, and also a dial indicator, provide for both coarse and fine travel of the quill being noted. An adjustable trip switch may be set in conjunction with the dial indicator to shut off the cutting power at an accurate end point of the machining operation.

The servo actuated quill is provided at its lower end with a short female taper in which may be mounted an electrode carrier direct, or a small three- or four-jaw chuck.

The electrical equipment is housed in a sheet metal floor standing cabinet adjacent to the rear of the mechanical unit, and matching the latter in width and contour.

Easily removable panels are provided for complete access to the equipment and inter-connections between the mechanical and electrical units are made by means of multi-way connectors.

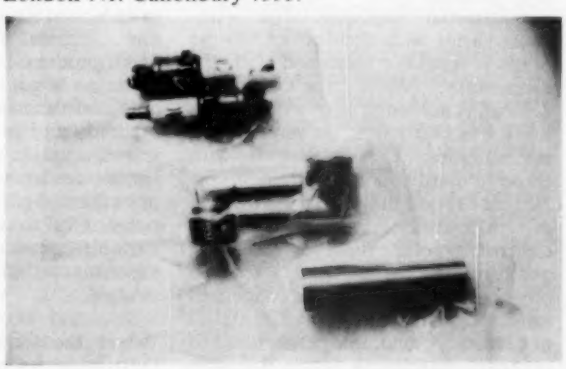
Three cutting ranges are selected by a lever switch. Alternative generators of different maximum power rating are offered with the finest cutting range similar in surface finish for either. The three indicator lights are amber for "mains supply on", green for "stand by" (indicating waterflow and equipment ready), and red for "cutting power" (float switch in work-tank closed).

The equipment includes features which are the subject of patents, and patent applications of Wickman Limited and the Method X Company.

Packing Components in Plastic

Originally developed for the food industry, the Clarovac vacuum pre-packing and sealing machine gives improved protection, preservation and clear view display for the packaging of small instruments, machined parts, electrical components, tools, etc. The articles are first packed by hand into plastic pouches, the machine then exhausts the air from the pouches and hermetically seals them under a high vacuum; thus ensuring complete protection against dust, rust and discoloration. An output of up to 660 pouches per hour is easily maintained by one unskilled operator.

The machine which is British made, operates on single phase, 50 cycles 220/240 volts and sells at £425.—M. L. Shelley & Partners Limited, 213/215 Upper Street, London N1. Canonbury 7993.



Engineering Mechanics. By Dwight F. Gunder and Derald A. Stuart. New York, 1959; John Wiley & Sons Inc. London: Chapman & Hall Limited. 62/- net (by post 63/6).

Two advantages of using vector methods in calculations with forces is that the forces are always defined in magnitude and direction and solutions are reached before much detailed arithmetic is required. Provided one knows one's vectors, therefore, one can keep a mental hold on the design process much more readily and relegate the arithmetic to another (and preferably equally systematic) process. This book does more than live up to its title, for besides being a book on mechanics it is also a practical text on the use of vectors in mechanical work. There is a separate chapter (No. 2) on vectors, but the rest of the subject matter is concerned with framed structures, equilibrium, problems in work and energy, friction, flexible cables, particle dynamics, relative motion, rigid body dynamics, and vibration. The authors consider that the vector rotation is more readily used by newcomers to the subject. It is certainly much more tidy and direct and for this reason alone a good many older engineers will find that this book will enable them to add the vector to their equipment. The book is pleasant to read.

Manual of Mathematical Physics. By Paul I. Richards. London, 1959; Pergamon Press Limited. £5 10s. net (by post £5 10s. 9d.). 486 pp. $6\frac{1}{2} \times 9\frac{3}{4}$ in.

For general reference this encyclopædic work replaces a whole library and the convenience it confers on the user is therefore immeasurable. It gives concise statements of laws and theories and both basic and applicational formulae. The treatment varies with the subject, so the book is nowhere burdened with the elementary, while the new or difficult is accorded ample space. The book has two parts: on physics and mathematics. The first deals with those "mathematical models of Nature" found in modern knowledge of mechanics, thermodynamics, electromagnetic theory, relativity, quantum mechanics, and statistical physics. The second part is concerned mostly with mathematical material not readily available elsewhere in compact, handbook form: it covers algebra, differentiation and integration, infinite series, vector analysis, determinants and matrices, the functions of a complex variable, integral transforms, ordinary and partial differential equations, integral equations, variational problems and linear programming, unitary spaces, eigenvalue problems and perturbation theory, probability and game theory, tensor analysis and group theory.

A pleasing feature of the book is the way in which continuity is maintained. Such a vast collection could easily have become a discrete compilation, but a series of comments and derivations does much to weld the whole into one body of knowledge. Each term and concept above the level of elementary calculus is defined somewhere in the text.

books

Recording Surfaces and Marking Methods.—National Bureau of Standards Circular 601 (Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., price 38 cents) by George Keinath, surveys and compares the characteristics of continuous traces, dotted traces, and printed characters produced by inking, incision, impression, indentation, deposition, heat, light, electric discharge, electron beam, magnetism, chemical action, or fluid streamlines. Descriptive and reference materials are included on three physical components of the recording system—the reservoir of material or energy, the marking point or matrix positioned by the measuring element, and the chart surface which preserves the record. Recorders are used for many purposes, but most frequently to supervise industrial processes and to carry out the mechanical, electrical and chemical testing of materials and products. This survey was undertaken to bring together available information on the various methods and problems of recording scientific and technical data. The survey covers some of the physical principles either currently or potentially available for recording variable measurands in laboratory experimentation or industrial production.

Where the Oil Comes From.—The Petroleum Information Bureau, 29, New Bond Street, London W1, has published the 1959 edition of the P.I.B. wall map indicating, by symbols, the relative importance of the world's oil producing and refining countries, together with statistics for 1958. The map, measuring 40 in. × 30 in., includes a diagram showing the sources of U.K. oil imports and a graph illustrating the remarkable growth of world oil production. Copies are available from the bureau at the above address, price 2/- each, post free.

Copper Abstracts.—Copper and its alloys are used in some form or another in practically every branch of industry, and the Copper Development Association, in order to draw attention to the latest developments now produce a publication each month which contains abstracts based on a survey of some of 120 technical journals and other relevant media, supplemented by detailed reproduction from other abstract journals. It replaces the former C.D.A. Technical Survey. The subject matter, devoted exclusively to copper and its alloys, is classified under appropriate sub-headings and each abstract is serially numbered for indexing in the December issue of each year. The association's office is at 55 South Audley Street, London W1.

Fuel Efficiency.—The fifth survey issued by the National Industrial Fuel Efficiency Service, 71 Grosvenor Street, London W1, is a lavishly produced brochure with illustrations in full colour. The service is having continued success with its work and all its main activities are being increasingly used by industry. The one exception is a reduction in the number of boiler operators coming to them for training. The savings to industry, too, are going up, having risen from 20·5 to 20·8% in the course of a year. This figure has only to be maintained, much less increased, for the existence of the service to be amply justified.

Portable Drills on Test.—The Consumers' Association Limited has been testing portable electric tools and gives the results in the November issue of its journal "Which?" Some of the well-known tools come through the investigation with but little criticism. It would seem that all the makes could be put above criticism by comparatively minor attention to certain details by the

manufacturers. Prospective buyers would certainly be interested in the report, which is, however, only available by subscription—necessarily so, apparently, since the association's income is derived in this way—so the cost of a new drill would be increased by the amount of the subscription (£1) unless one's buying were helped by other reports in the course of the year, which, of course, is very likely. Incidentally, the November issue also contains a report on 35 mm cameras.

Guide to Transistors.—A technical and business guide to transistors has been published by Heywood & Co. Limited, Drury House, Russell Street, Drury Lane, London WC2, price 5/-. It contains much useful tabular information on transistor devices, their characteristics, applications and performance; and an equally useful guide to manufacturers.

The V-type Engine.—The paper by Mr. G. Hopwood, "Development of the V-type Engine", presented to the Diesel Engineers and Users Association in March last has been reprinted as a 32-page booklet. It contains the full text with illustrations and also text of discussion at the meeting. The booklet is priced 15/- from the Association's offices at 18, London Street, London EC3.

Plastics Moulds.—A "Yellowback" of this title, by R. N. B. Miller, has been published by Machinery Publishing Company Limited, price 5/-. It explains the design of injection moulds, compression moulds and transfer moulds for the production of components in plastics materials.

Engineers and Shipbuilders in Scotland.—The latest (1959) list of members of The Institution of Engineers and Shipbuilders in Scotland describes the institution and its work, and lists its distinguished members as well as the full present membership. The address of the institution is 39 Elmbank Crescent, Glasgow C2.

New Standards

Power-driven mast hoists for materials (B.S. 3125:1959). Price 5/-.

This new 20-page illustrated standard provides guidance for the manufacturer and the user of builders' hoists of the mast type. It specifies requirements for a non-passenger power driven hoist not exceeding 50 cwt capacity, for temporary use on construction work, in which a platform for lifting materials is supported and guided by a mast. The standard requires that minimum safety requirements be observed and that design and testing are, as far as possible, in conformity with cranes in general. Qualities of material and equipment are specified for all important parts. For this purpose, a 4-page appendix lists specified British Standards under five main headings: materials, structural details, machinery and machinery details, electrical machinery and equipment, lifting equipment. One of the four appendices summarizes 19 items of information which the manufacturer should supply with a tender. In dealing with the design of these hoists, full consideration has been given to the eccentric loading of the platform.

Charpy V-notch impact test (B.S. 131: Part 2:1959). Price 4/-.

Issued as Part 2 of the British Standard on the notched bar testing of metals, this new publication specifies the conditions for carrying out the Charpy V-notch impact test. "The test", explains the standard, "consists of measuring the energy absorbed in breaking by one blow from a pendulum a test piece notched in the middle and supported at each end". Whereas the previous edition of the standard gave only nominal dimensions of test pieces, the new edition gives dimensions with appropriate machining tolerances. The tolerances for ferrous test pieces are in accordance with a recommendation of the International Standards Organization, but for non-ferrous materials a more restrictive tolerance has been applied to the dimensions of the test piece. Three new subsidiary test pieces have been specified to replace the two specified in the previous edition and these are intended for use when it is impossible to obtain a standard test piece from the material available. Two of the sizes selected meet the particular requirements of manufacturers of tubes. The structural and dimensional aspects of the testing machine are fully dealt with; and an appendix gives recommendations for its installation.

Soft solders (B.S. 219:1959). Price 4/-.

This revised publication includes the requirements for the ten grades of soft solder for general use specified in the 1949 edition, together with requirements for four additional solders: N and H which had been included in an earlier edition of the standard, V which is identical with a solder specified in B.S. 441 "Rosin cored solder wire", and R, a non-antimonial version of solder M. Requirements relating to three solders for service at higher temperatures which were previously referred to in an appendix, now appear in Section Three of the standard. These solders have been designated by their maximum tin content followed by a letter indicating the major alloying element, to distinguish them from the solders for general use, which are designated by letters as in the earlier edition.

Enamelled copper conductors (enamel with polyester base) Part 1: Round wire (B.S. 3160: Part 1: 1959). Price 8/6.

This new publication extends the range of British Standards for enamelled winding wires to include enamels based on terephthallic acid polyester resins, which are generally suitable for higher operating temperatures than those of the polyvinyl acetal type covered by B.S. 1844. The requirements are similar to those specified in B.S. 1844: Part 1, but some of the test temperatures are 30–50°C higher. The range of wire sizes standardized extends from 0·002 in. dia to 0·16 in. dia. Four standard thicknesses of covering are provided over most of this range.

Characteristics of flexible couplings for power transmission (B.S. 3170: 1959). Price 4/6.

The performance characteristics of flexible couplings for shafts, together with keyways, limits and fits and bore sizes, are dealt with in this new British Standard (14 pp., 3 diagrams). The standard does not apply to flexible shafts. A series of general requirements is followed by sections on dimensions, limits and fits; components; marking; and guarding. An appendix provides notes on methods of checking angular and parallel alignment of couplings.

British Standards Institution, 2 Park Street, London, W1.

BUSINESS & PROFESSIONAL

Personal

THE ROYAL SOCIETY announces that **Professor R. E. Peierls, C.B.E., F.R.S.,** professor of mathematical physics in the University of Birmingham, has been awarded one of the two Royal Medals for the current year for his distinguished work on the theoretical foundations of high energy and nuclear physics. The Hughes Medal has been awarded to **Dr. A. B. Pippard, F.R.S.,** reader in physics in the University of Cambridge, for his distinguished contributions in the field of low temperature physics.

Mr. A. H. Mumford, O.B.E., deputy engineer-in-chief, G.P.O., is appointed engineer-in-chief in succession to **Brig. Sir Lionel H. Harris, K.B.E., T.D.,** who is retiring on January 31, 1960. **Capt. C. F. Booth, C.B.E.,** assistant engineer-in-chief, and **Mr. D. A. Barron,** assistant engineer-in-chief, have been appointed to be deputy engineers-in-chief from February 1, 1960.

Lieutenant-Commander Douglas F. Battison, R.N. (Retd.), has been appointed sales manager of Electropol Processing Ltd., pioneers of the world-patented "Electropol" method of electro-polishing stainless steel.

Mr. Tibor Haas, Dipl. Ing., A.M.I.Mech.E., A.F.R.Ae.S., has been appointed head of the design section in the newly formed members' service department of British Welding Research Association, Abington, Cambs.

Mr. G. B. R. Feilden, F.R.S., managing director of Hawker Siddeley Brush Turbine Company and chairman of National Free Piston Power Limited, has been appointed to the board of Hawker Siddeley Industries Limited.

As part of their sales expansion programme, The Hymatic Engineering Company Limited, Redditch, Worcs., announce the following appointments in their hydrovane compressor division: **Mr. G. Seaton,** formerly sales representative in Northern England becomes senior representative responsible for all outside selling work. **Mr. D. R. Morgan** has been appointed sales representative in Northern England. **Mr. W. H. Wheeler** formerly sales representative in the East Midlands now takes over a new Midlands territory concentrated on Birmingham. **Mr. G. P. Webb** previously based on Warwickshire and Worcestershire now becomes sales representative in South Eastern England excluding London and Middlesex. **Mr. L. G. Calvert** has been appointed sales representative in London and Middlesex.

Mr. Herbert Slack, has been appointed to the board of Kelvin & Hughes (Industrial) Limited as sales director. Mr. Slack was formerly technical sales manager.

KERRY'S (GREAT BRITIAN) LIMITED, announce that **Mr. L. R. Baker,** who has been the company's export manager for a number of years, has taken up an appointment with the Machine Tool Trades Association. **Mr. G. S. Hillier,** sales manager of the Kerry manufacturing division, whose department is being expanded, has taken over the duties as export manager, in addition to being responsible for home sales of the manufacturing group's products. **Mr. Ian A. Ross, F.C.C.S., A.C.A.,** has been appointed a director of the parent company.

Mr. C. J. Beavis has been appointed by Birlec-Efco (Melting) Limited to take charge of all Birlefco's smelting activities. Formerly works engineer for The Distillers Company Limited at their factory near Port Talbot in South Wales, Mr. Beavis was responsible for all engineering construction and maintenance required for the production of calcium carbide.

Mr. H. S. Rainbow, A.F.R.Ae.S., has been appointed chief engineer of Perkins Outboard Motors Limited, a subsidiary of F. Perkins Limited. He has joined the Peterborough company from Bristol Siddeley Engines Limited, where he was in charge of project and mechanical design of a high-powered turbo-jet engine for long-range supersonic flight and also a range of ultra-lightweight lifting engines for vertical take-off aircraft.

Mr. D. N. Steeley has been appointed sales manager of Standard Industrial Motors at the G.E.C. Engineering Works, Birmingham. Mr. Steeley was formerly an assistant branch engineer in London.

ENGLISH ELECTRIC VALVE COMPANY Limited, announce that **Mr. A. J. Young, B.Sc.(Eng.), M.I.E.E.,** has been elected to the board and appointed managing director. **Mr. F. N. Sutherland, C.B.E., M.A., M.I.E.E.,** has also been appointed to the board of the Company.

Mr. Cyril Bayton, chief mechanical engineer of Taylor Woodrow Construction Limited, has been appointed to the board of Taylor Woodrow Plant Company Limited, a member of the Taylor Woodrow Group of building and civil engineering companies. **Mr. Barton Frank Higgs, B.Sc., A.M.I.C.E.,** has been appointed managing director of Myton Limited, of Hull and London, a member of the Taylor Woodrow Group.

AFTER 27 years' service with The Plessey Group of Companies **Mr. J. R. Thomas** has now retired. Mr. Thomas was at one time general manager of the Plessey Kembrey Street factory, Swindon, and later director of the Amar Tool and Gauge Company Limited, Chadwell Heath. **Dr. D. W. Davison, F.Inst.P., F.I.M.,** has been transferred to the central personnel executive staff at the head office of The Plessey Company Limited, Ilford, to assist the personnel director with scientific and technical appointments throughout the company and its associates. The appointment is also announced of **Mr. R. E. Verguson, M.S.M.A.,** as commercial manager of a new grouping which includes the sheet metal division and the Amar Tool and Gauge Company Limited with the industrial hydraulics division, at Cheney Manor, Swindon.

EDGAR ALLEN & CO. LIMITED announce the recent retirement of **Mr. H. D. Boyd,** a director of the company. Newly appointed directors are **Mr. F. A. Ross, Mr. W. G. A. Jenkins,** and **Mr. J. Higginbotham. Mr. F. S. Marsden** has been appointed transport and traffic manager of the company in succession to Mr. C. Shaw, whose retirement was recently reported.

THE INCANDESCENT HEAT COMPANY Limited, Smethwick, are seconding **Mr. B. A. Harper** to the staff of A.B.M.T.M. (India) Limited, their representatives in India for almost half a century. His post will be that of senior furnace technician (India).

THE PRESSED STEEL COMPANY LIMITED announces that **Mr. Cecil F. Tracy** has joined its organization as a divisional director of the Prestcold division with the title of production director of the new Swansea plant.

Mr. T. L. Booth, previously director and general manager of Hepworth & Grandage (Yeadon) Limited, has been appointed to the board of the Hepworth & Grandage Limited parent company. **Mr. H. Forrest,** director and works general manager of the Hepworth & Grandage main factory at Bradford, has been appointed to the board of Hepworth & Grandage (Yeadon) Limited, and the general managership of the Yeadon factory, previously the responsibility of Mr. Booth, will now be taken over by **Mr. A. Rowntree,** who will be assisted by **Mr. E. Boyes.**

UNION CARBIDE LIMITED announces the following changes in the responsibilities of senior executives in the company. **Mr. L. E. Whitmore** becomes director and general manager, Polyethylene Division. **Mr. J. F. Widman** previously director of marketing, Chemicals, becomes director and general manager, Chemicals Division. **Mr. R.**

Wilson has been appointed a director and becomes director and general manager, Alloys Division. The Alloys Division announce the following executive appointments within their sales organization: **Mr. Colin Dunger,** previously area sales manager, Sheffield, is now assistant sales manager. **Mr. William Smith,** the company's technical sales representative in Scotland for some time, is appointed area sales manager—Scotland. Office: 266, Clyde Street, Glasgow, C1. **Mr. William Paton** has transferred from the Division's development department to take charge of the sales department's Birmingham area, and is now area sales manager, Birmingham. Office: Beaufort House, 92 Newhall Street, Birmingham 1.

Mr. Thomas G. Ellison and **Mr. Arthur E. Skan** have been appointed joint managing directors of George Ellison Limited manufacturers of electric switchgear and motor control gear in Birmingham for over half a century. Mr. Ellison is a son of the founder of the company, the late Mr. George Ellison, and has been a director since 1929. He was elected chairman of this and of the associated companies Alfred Ellison Limited and Tufnol Limited in 1955.

Mr. C. P. Paton is taking up an important position with Aluminium Limited of Canada in Montreal, and has accordingly resigned from Northern Aluminium Company Limited. **Mr. Taylor Cornelius,** who has taken over from Mr. Paton as Northern's general works manager, was elected a director of the company. Mr. Cornelius was until recently a vice-president of Aluminium Company of Canada Limited and manager of that company's fabricating division.

THE following appointments have been made in respect of wholly owned subsidiary companies of English Steel Corporation Limited.—**Mr. W. D. Pugh** to the office of chairman of English Steel Forge and Engineering Corporation Limited, English Steel Rolling Mills Corporation Limited, English Steel Castings Corporation Limited, English Steel Spring Corporation Limited, Taylor Bros. & Co. Limited. **Mr. W. E. A. Redfern** to the office of managing director of English Steel Forge and Engineering Corporation Limited. **Mr. R. G. H. Taylor** to the office of chairman of English Steel Export Corporation Limited. **Mr. G. Craven, D.S.C.,** to the office of managing director of English Steel Export Corporation Limited. The following new appointments have been made within English Steel Forge and Engineering Corporation Limited: **Mr. R. W. Brocklehurst,** director, general superintendent. **Mr. E. Levesley** from manager to superintendent of the forge machine shops. **Mr. R. J. H. Hunt** from manager to superintendent of the heavy forge.

Admiral Sir Michael M. Denny, G.C.B., C.B.E., D.S.O., has been appointed a director of English Steel Corporation Limited.

Mr. A. A. Thornbrough, president of Massey-Ferguson will for the time being assume executive direction of United Kingdom Operations as managing director. Massey-Ferguson (Great Britain) Limited will change its name to Massey-Ferguson (United Kingdom) Limited, which company will provide the central management functions required. **Mr. Eric Young** will be deputy managing director. **Mr. Lionel Harper,** who is also a member of the board of Massey-Ferguson Holdings Limited, has been appointed assistant managing director in the United Kingdom Operations group.

Mr. H. P. Forder and **Mr. A. R. Hay** have been appointed directors of the United Steel Companies Limited. Mr. Forder is director and general manager of the Samuel Fox and Company Limited subsidiary of the company and Mr. Hay is a director of Naylor, Benzon & Company Limited who represent United Steels in the Newcastle area. **Mr. H. Morley** has been appointed a director of Samuel Fox and Company Limited. Mr. Morley joined the company in 1934 and was appointed general works manager in 1958. **Mr. P. Beynon** has been appointed works manager, operational research and work study at Steel, Peech and Tozer.

BROOK MOTORS LIMITED announce that **Mr. Walter Ford** formerly a sales engineer at the firm's Birmingham office has moved to the Swansea sales office of the company as manager. He has previous experience of the Swansea area working there from 1951 to 1957. **Mr. Peter Martin,** previously a sales engineer with the Huddersfield office, has succeeded Mr. Ford at Birmingham.

FOLLOWING the recent move by the company's head office to 12 Stratford Place, London W1, Firth Cleveland Finance Limited have made the following appointments: **Mr. G. L. Neate,** general manager (new business): **Mr. W. J. Waters,** general manager (administration).

Mr. J. A. Kemp, a director of Albion Motors Limited, has relinquished his position as the company's chief designer, a post he has held for the past 25 years. His services have been retained by the company in an advisory capacity. **Mr. E. B. Stead,** formerly technical manager, has been appointed chief engineer.

Mr. H. E. Purcell has been appointed to the board of directors of George Cohen (Dublin) Limited.

Mr. C. Dee, F.R.S., has been elected to the board of Associated Automation Limited.

Obituary

WE deeply regret to have to record the death of an esteemed and respected colleague, **William Henry Spurr,** who up to the time of his death at the age of 83 was Chairman of Emmott & Co. Limited, publishers of *Mechanical World.* He had been with the company for more than 60 years, joining it as assistant secretary in the early years of its formation under its founder, the late W. T. Emmott. He served it successively as secretary, manager, managing director, and for many years was permanent director and chairman. It was due to his hard work, foresight and tenacity of purpose over the years that the company and its journals were built up and soundly based. A man with definite ideas and ideals of his own he nevertheless readily appreciated those of others and encouraged energy and initiative in his younger associates, both in business and in private life. He was well read, had a remarkable memory and was a notable raconteur. His genial personality and gentle disposition made him many friends by whom he will be greatly missed.

WE regret to record the death of **Mr. Alfred George Wilson** at the age of 49 years. Mr. Wilson was apprenticed at the Norwich works of Laurence, Scott & Electromotors Limited in 1926, and subsequently became Service Manager (1942) and Production Manager (1945).

WE regret to record the death of **Mr. J. N. Bull, B.A.(Cantab.), A.M.I.Mech.E.,** locomotive works manager, St. Rollox, Glasgow. He was 54 years of age.

WE regret to record the death of **Mr. Claude R. Bicknell** a former Siemens Edison Swan lighting specialist. Mr. Bicknell retired in 1957 after 44 years' service with the company, which he represented on various technical committees.

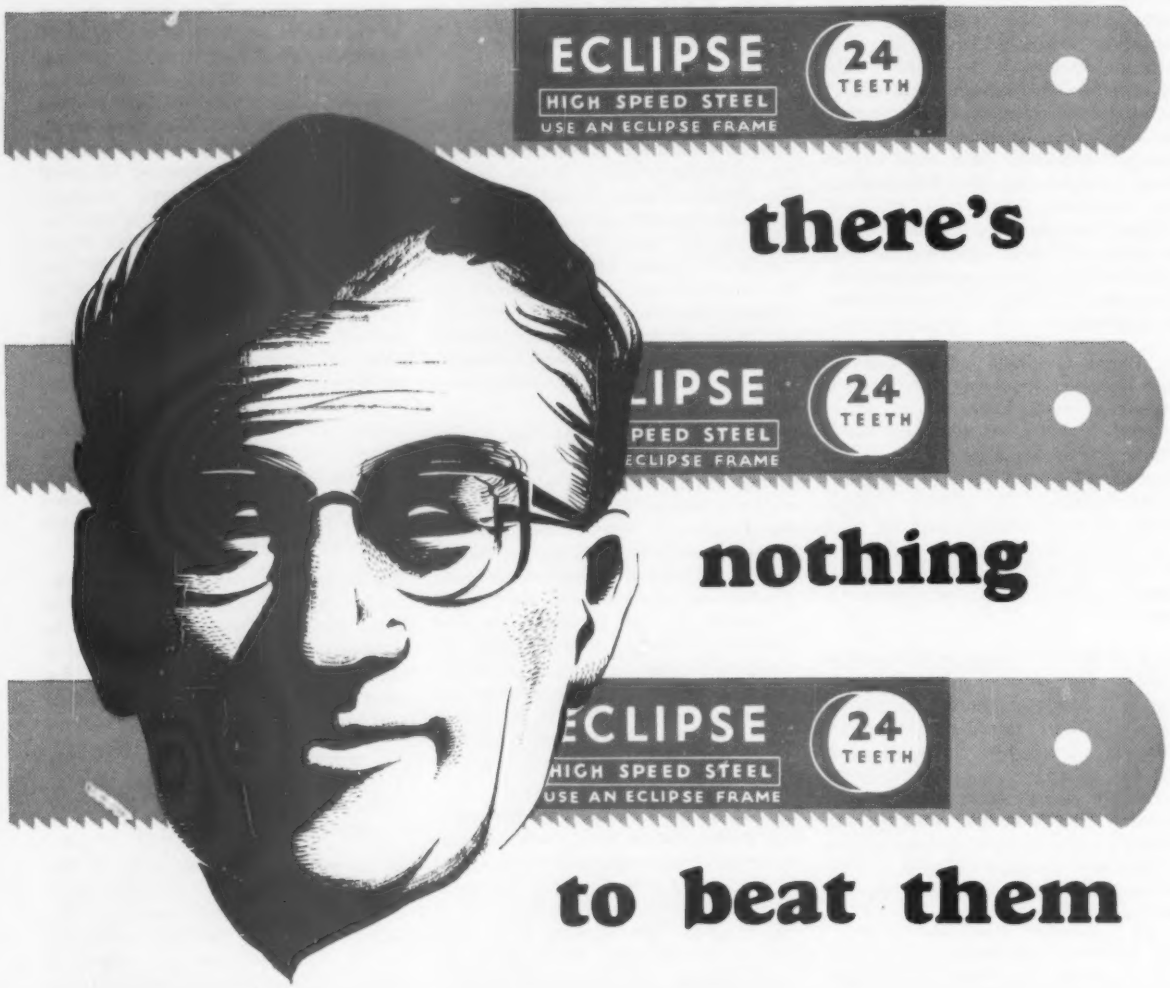
Addresses

BRITISH INSULATED CALLENDER'S CABLES Limited, Carlisle branch office, in addition to the existing telephone number, Carlisle 22221, now has the number Carlisle 25093.

THE CONSOLIDATED PNEUMATIC TOOL Company Limited of 232 Dawes Road, London SW6, have opened a new district office in Bristol at 1 Bedminster Down Road, Bristol 3, Telephone number Bristol 63736. The new office is under the management of Mr. J. D. Glover and its operations will cover the counties of Somerset, Devon, Cornwall and part of Gloucester.

THE KEITH BLACKMAN LIMITED office has now moved to 1651 Pershore Road, Birmingham 30. Telephone Kings Norton 4151/2. The Telex number remains the same—33185.

for speed and long life



Eclipse

HACK SAW BLADES

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UH37

BUSINESS & PROFESSIONAL

GRIFFIN & GEORGE LIMITED of Ealing Road, Alperton, Wembley, have now opened a branch at 626 Welbeck Road, Walker, Newcastle upon Tyne.

GRESHAM AUTOMATION LIMITED of Gresham House, Twickenham Road, Hanworth, Middlesex, has been formed to advise on complete automation schemes and the supply of Gresham Unit Sequencing Systems, together with all other ancillary instruments and controls. The directors are Mr. John P. Coleman, M.I.E.E., chairman of Gresham Transformers Limited, and the Gresham Lion Group and Mr. R. M. Campbell, also a director of Gresham Transformers Limited. Also, as a consultant to the board, is Dr. D. B. Foster, Ph.D., M.I.Mech.E., M.I.E.E., M.I.Chem.E., F.Inst.Fuel.

THE Manchester office of Talbot Stead Tube Company Limited is now at Friargate House, 42 Deansgate, Manchester 3. Telephone number, Deansgate 5078, remains unaltered.

THE HENDRY ORGANIZATION comprising John W. Hendry and Staff Limited, School of Work Study Limited, Film Projects Limited and Careers Consultants Limited, has removed to 11 Old Burlington Street, Piccadilly, London W1. Telephone as before; REGent 0516/7/8.

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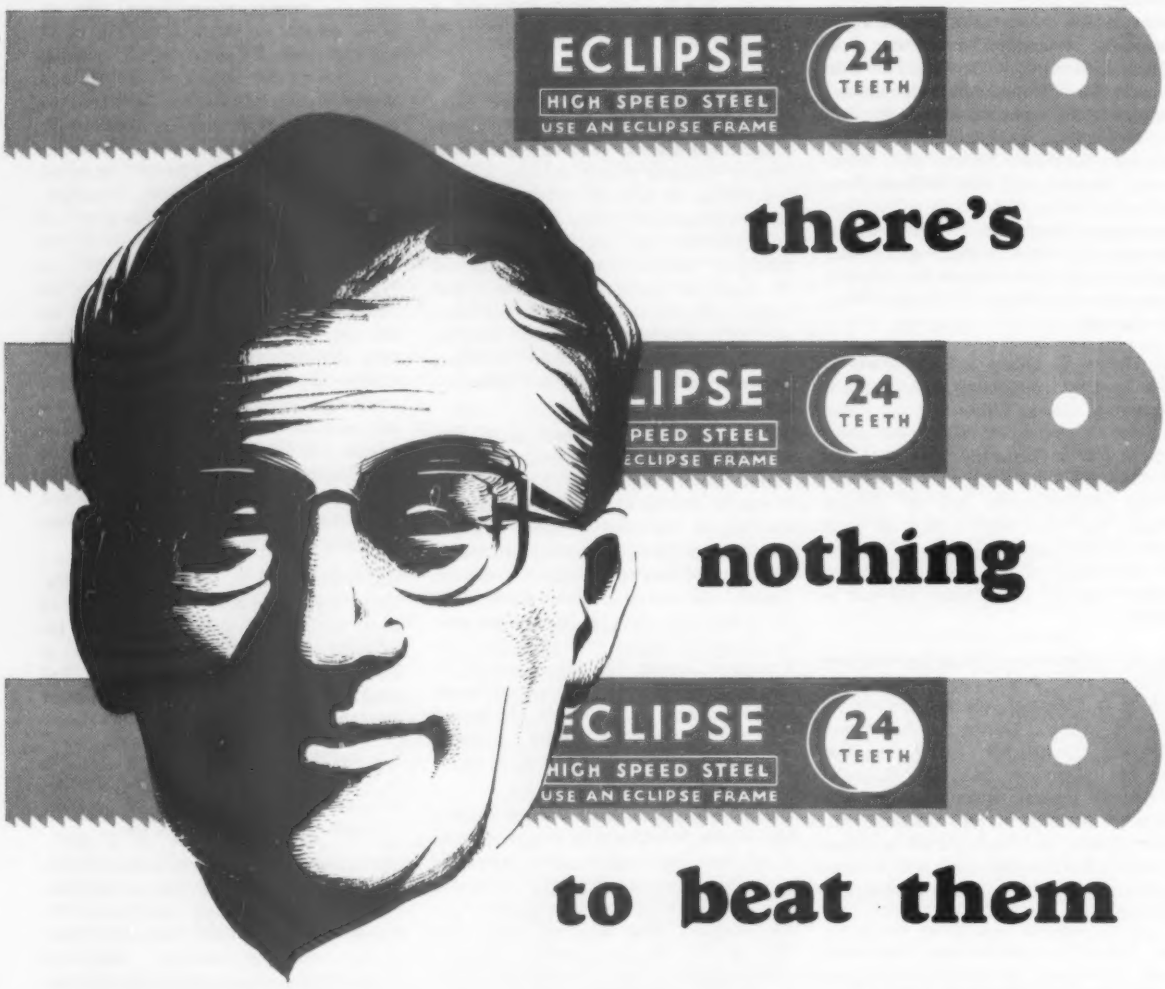
for speed and long life



Eclipse

HACK SAW BLADES

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

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GRIFFIN & GEORGE LIMITED of Ealing Road, Alperton, Wembley, have now opened a branch at 626 Welbeck Road, Walker, Newcastle upon Tyne.

GRESHAM AUTOMATION LIMITED of Gresham House, Twickenham Road, Hanworth, Middlesex, has been formed to advise on complete automation schemes and the supply of Gresham Unit Sequencing Systems, together with all other ancillary instruments and controls. The directors are Mr. John P. Coleman, M.I.E.E., chairman of Gresham Transformers Limited, and the Gresham Lion Group and Mr. R. M. Campbell, also a director of Gresham Transformers Limited. Also, as a consultant to the board, is Dr. D. B. Foster, Ph.D., M.I.Mech.E., M.I.E.E., M.I.Chem.E., F.Inst.Fuel.

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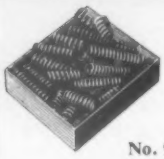
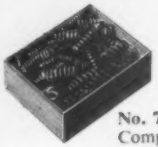
"If only I had an 18G ¾" expansion spring!"

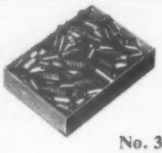
No. 760. 3 doz. Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. 6/6 each.



No. 98A. 3 doz. Assorted 1" to 4" long, ½" to ¾" diam., 19G to 15G. 5/6 each.



No. 757. Extra Light Compression, 1 gross Assorted, ½" to 1/16" diam., ½" to 2½" long, 27 to 19 S.W.G. 15/- each.



No. 388. ½ gross Assorted Small Expansion Springs. ¾" to 1½", 18G to 21G. 9/6 each.

No. 758. Fine Expansion Springs. 1 gross Assorted ½" to ⅝" diam., ½" to 2" long, 27 to 20 S.W.G. 15/- each.

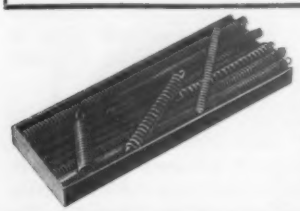
No. 466. ½ gross Assorted Small Expansion Springs ¾" to 1½" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each.

There he is—stuck for a vital spring, the job hung up, all because he can't put his hand on the very thing needed to finish it. Don't be caught out like this—make practical use of TERRY'S BOXES OF ASSORTED SPRINGS where you'll find the exact spring you need for a thousand and one propositions. These handy boxes hold a wonderful variety of springs of every kind—compression, expansion, heavy, light, long, short, in the gauge you want —just when you want it.

Why not let us send you our fully illustrated list of BOXES post free?

HERBERT TERRY & SONS LTD
Redditch, Worcs.

(*Makers of Quality Springs, Wireforms and Presswork for over 100 years*)



No. 1024. 20 Compression Springs 12" long. ¼" to ½" diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansion 1½" to 12" long, 5/32" to ⅝" diam., 22G to 16G. 24/- each.

TERRY'S ASSORTED SPRINGS

Cut production costs with Terry Wire CIRCLIPS (*Square Section*)
We can supply from stock in sizes from ⅛" to ⅝".

Have you a Presswork problem? If so let us have it and we'll help to solve it for you.

★Interested in Springs? Ninth Edition of "Spring Design & Calculations"—post free 12/6

H.T.37

Business Developments

Trading Agreements

THE full line of Clark compressors is now available in sterling bloc countries because of a manufacturing agreement completed between G. & J. Weir Limited, of Glasgow and Clark Bros. Company Division of Dresser A.G.

DICKOW pumps designed and developed by Dickow-Pumpen, of Wailkrayburg, near Munich, Western Germany, will now be manufactured under licence by Firth-Cleveland Pumps Limited, Stornoway House, Cleveland Row, London SW1.

THE termination by mutual consent of the manufacturing agreement between Humphreys and Glasgow Limited and Alco Products Incorporated of New York is announced. The former company now offer a similar range of comprehensive power stations designed and manufactured by Babcock and Wilcox Limited.

AGREEMENT between the Lester Engineering Company, U.S.A. and Brockhouse enables the latter company to build, under licence, the 4/6 and 6/9 oz. injection moulding machines for sale in the U.K. and throughout the Commonwealth.

ASSOCIATED ELECTRICAL INDUSTRIES Limited of London, and Alco Products Inc. of New York are to collaborate in the design, manufacture and sale of diesel-electric locomotives for world markets.

ELLIOTT-AUTOMATION are in negotiation with Manufacture de Machines Du Haut-Rhine S.A. ("Manurhin") of Mulhouse, France, for the manufacture in France of Automation equipment.

THE sole right to manufacture in the United Kingdom Hudson hollow plastic industrial fans, to be sold under the trade name of "Marex", has been acquired from the Hudson Engineering Corporation of Houston, Texas, by Marston Excelsior Limited, a subsidiary company of I.C.I. Limited.

Company Acquisitions

HILGER AND WATTS have acquired the whole of the issued share capital of The Infra Red Development Company Limited, of Welwyn Garden City.

THE railway spring making business of W. Griffiths & Sons Limited, of Brightside Lane, Sheffield, has been acquired by English Steel Spring Corporation Limited.

SHARPLES CENTRIFUGES LIMITED have recently purchased the German company Gesellschaft für Trenn- und Trockentechnik m.b.H., who manufacture the Contessor conical screen centrifuge. Sharples Centrifuges Limited have also purchased the centrifugal division of the Fletcher Works Inc., U.S.A. which will in future be known as the Fletcher division of Sharples.

THE assets and business of Fischer Bearings Company Limited of Wolverhampton, one of Timken's British subsidiaries, are now to be purchased by Fafnir Bearings Company Limited (U.K.). Agreement to this effect has been reached between The Timken Roller Bearing Company of Canton, Ohio, and the Fafnir Bearing Company of New Britain, Connecticut, U.S.A.

NEGOTIATIONS for the acquisition by Baker Perkins Limited of the major part of the business of William Douglas & Sons Limited of Putney, London, are about to be completed.

THE whole of the share capital of Pipeweld Limited (Paston Road, Wythenshawe, Manchester 22) has been acquired by Powell Duffryn Limited.

Agents and Distributors

RESEARCH AND CONTROL INSTRUMENTS Limited now become sole distributors in the U.K. for the industrial products at present marketed in the U.K. by its associated company, Philips Electrical Limited.

ALFRED HERBERT LIMITED, Carliol Square, Newcastle 1, have been appointed agents for Crawford Collets Limited, of Witney, for north-east England.

WILLIAM H. CAPPER & CO. LIMITED, Mayfair House, 8/9 Hertford Street, London W1, have been appointed sole representative in the U.K. and Northern Ireland for the sale of all products of the Compressor Division of Demag A.G., of Duisberg.

EVERSHED & VIGNOLES LIMITED have reorganized and enlarged their Canadian activities and have formed a new company to be known as Evershed-Powertronic Limited. The famous ranges of "Megger" insulation testers and other electrical testing instruments manufactured by Evershed and Vignoles Limited will continue to be handled in Canada by R. H. Nichols Limited, who have sole rights.

THE HYMATIC ENGINEERING COMPANY Limited of Redditch, Worcs., have appointed as their distributors in Holland of Hymatic Hydrovane mobile and portable compressors, Nellen Technische Handelmaatschappij, Postbus No. 929, Jan Evertsenplaats 221, Rotterdam.

Contracts and Work in Progress

FARRAR BOILERWORKS LIMITED, Newark.—A further Polish order value £90,000 for five Farramatic fish-meal plants.

FERRANTI LIMITED, Hollinwood.—Order value £280,000 placed by the AB Turitz & Company of Gothenburg, Sweden, for the first Orion data-processing system.

Large electronic computing system for The British Petroleum Company Limited, costing over £¼m.

Order from the Electricity Corporation of Nigeria for transformers worth over £70,000.

BAKER PERKINS LIMITED, Peterborough.—Contract for the Bedewell Division at Hebburn on Tyne for the supply of foundry equipment to E.G.O. Elektro-Gerate, Blanc u. Fischer, Oberderingen, Wurttenburg.

E.M.I. ELECTRONICS LIMITED, Hayes, Middlesex.—Two further electronically controlled positioning systems for the Derby factory of Rolls-Royce Limited, aero engine division.

Two air-conditioned outside broadcast units for the Australian Broadcasting Commission.

BROOKHIRST IGRANIC LIMITED (M.I. Group).—Order for electric control gear valued at £89,000 for the Northfleet power station extension placed by C.E.G.B. and the dispatch of the first ten of 60 sets of controls for sugar centrifugals to Thomas Broadbent & Sons of Huddersfield, who are manufacturing the machines for shipment to Formosa, where the sugar industry is being re-equipped.

AVO LIMITED (M.I. Group).—Supply of 140 Radiac survey meters to the Government of Eire Defence Department.

FAWCETT PRESTON & CO. (M.I. Group).—Supply of thermatic extruder for Standard Telefon og Kabelfabrik A/S, Oslo.

SANDERS & FORSTER LIMITED. (Chamberlain Group).—Order for S & F Clear Portal Standard buildings for use in the Warri Dockyard (Nigeria) Limited.

ASHMORE, BENSON PEASE & CO. LIMITED, (Power-Gas Group).—Contract valued at about £4m for the supply of two complete blast furnaces for Richard, Thomas & Baldwins Limited.

P.G. ENGINEERING LIMITED (Power-Gas Group).—Contract with V/O Techmashimport, Moscow, for supply of plant for the production of polystyrene with rated capacity of 5000 tons a year. Process design to be supplied by BX Plastics Limited.

WILD-BARFIELD ELECTRIC FURNACES Limited.—Gas carburizing furnaces for the Rover Car Company Limited and for Leyland Motors Limited with Carbodrip drip feed method.

SOLARTRON ELECTRONIC BUSINESS MACHINES Limited, (Solartron Electronic Group).—Electronic reading automaton for Domestic Electric Rentals Limited.

TAYLOR WOODROW (ARCON) LIMITED.—Contracts worth over £50,000 placed by Ransomes & Rapier Limited for steel-framed buildings.

[*Continued over*]

Lighting - 3

Data Sheet No. 7 dealt with some actual applications of factory lighting. Further applications are given here.

Drawing Offices

It is fair to say that in no part of a factory is good lighting more important than in the drawing office. The draughtsman's task is extremely exacting and unless the illumination is up to required standards, mistakes, loss of time and greater fatigue will result.

The essential requirements are:

High value of illumination
(*minimum of 30 foot-candles on the boards*)
Absence of shadows
Absence of reflection

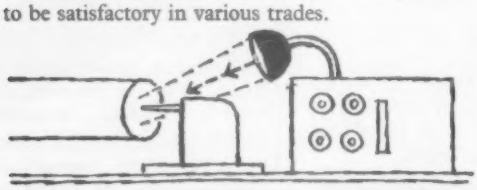
One of the major problems is the reflection of the light sources by shiny tracing paper, instruments, set-squares, etc., and particularly by the extra-hard pencil leads often used. Another problem is that caused by the shadows ahead of T-squares and by the variety of angles at which drawing boards are set.

Fluorescent lighting is particularly suitable because of its comparative freedom from shadow, its natural colour and because it can be localised with respect to drawing boards to avoid reflections while at the same time giving enough light upward and sideways to satisfy the general lighting requirements of the office.

A lighting solution which has been successfully employed for tracing is to light from beneath and through the paper which is fixed on to a translucent panel, thus eliminating the problems of shadow and reflection.

Machine Shops

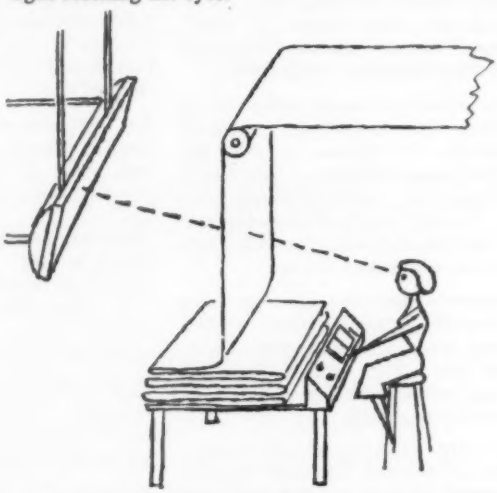
The problems of machine-shop lighting vary so widely that it is impossible to lay down rigid rules which are applicable to all types of machine. Much of the design of such lighting systems must therefore be a matter of individual application. Certain maxims, however, have proved in practice to be satisfactory in various trades.



There is a strong case for the provision of local lighting on many machines to enable the direction of light to be varied to suit the work, or to boost the illumination for fine work.

In shops employing certain machine tools, particularly circular saws, the possibility of stroboscopic effects can be avoided by splitting lamps among the phases of a three-phase supply or by using twin lamp fittings with a split-phase circuit.

Where safety goggles are used, extra illumination should be provided to compensate for the reduced light reaching the eyes.



Silhouette inspection of fabrics or profiles can often be used to advantage by placing a light source behind the material to be inspected — on the lines of the back-lighting already referred to for tracing in the drawing offices.

In general, machine-shop lighting is essentially an empirical science, based largely on a combination of general and local lighting, which offers immense scope for ingenuity.

Outside Lighting

The outside precincts of a factory are often much neglected. No special rules can be suggested for lighting these areas, but speed, efficiency and safety are all dependent on adequate outside illumination during the hours of darkness.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each or 9/- post free) are available—"Lighting in Industry" is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity, including one on industrial lighting. Ask for a catalogue.

7932

Contracts and Works in Progress—*continued*

ENGLISH ELECTRIC COMPANY LIMITED.—Order value about £383,000 for two 310 MVA generator transformers for C.E.G.B. BLACKSTONE & CO. LIMITED, Dursley, Glos.—Diesel generating plant for the Nigerian Government.

Supply of 1800 hp a.c. winder for East Midlands Division of National Coal Board. The new winder will replace the steam winder which has been in service for over 60 years at the No. 1 shaft of Creswell Colliery, near Worksop. Robey & Company Limited, of Lincoln, are sub-contractors for the mechanical equipment.

THE COLCHESTER LATHE COMPANY, Essex. (600 Group).—Export orders for machine tools received over the last two months have brought the total value to over £300,000.

ENGLISH ELECTRIC VALVE COMPANY Limited, Chelmsford.—Order from Collins Radio Company for $100,000 for Klystron type K350 tubes which will be used in American-built Doppler navigation equipment.

HEENAN & FROUDE LIMITED, Worcester.—The Swedish motor car manufacturers, Volvo Limited, have ordered nine Heenan-Dynamatic dynamometers.

Specially designed tyre test plant for London Transport.

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—*Turbine Generator Division:* order for A.E.I. Export Limited value over £400,000 from Basrah Petroleum Company Limited for gas turbine generators; two 200-MW turbine-generators for Hazelwood Power Station—State Electricity Commission of Victoria, Australia. *Switchgear Division;* £1m. contract placed by Central Electricity Generating Board for switchgear for Thorpe Marsh power station, near Doncaster and £900,000 contract for switchgear for Trawsfynydd, N. Wales power station. *Transformer Division:* Large arc furnace transformer for the English Steel Corporation Limited, Sheffield, in conjunction with Birlec-Efco (Melting) Limited. *Heavy Plant Division:* Contract placed by Ardal og Sunndal Verk, Norway, for a 108,000 kW rectifier installation for aluminium smelting plant; dollar order valued at about £190,000 for large turbine-driven centrifugal blower for a catalytic cracking plant in the new Duque de Caxias oil refinery at Rio de Janeiro; diesel-driven A.E.I. brushless alternators for oil terminal in the Arabian Gulf.

BRITISH TRANSPORT COMMISSION.—Amongst contracts placed by the Scottish Region, British Railways, is one for diesel maintenance and fuelling facilities at Inverness from James Campbell & Son (Building Contractors) Limited, and another for an 8 ton fork truck for Glasgow goods depots from Ransomes & Rapier Limited, Ipswich.

WILLIAM BOBY & COMPANY LIMITED, Rickmansworth.—Contract awarded by Courtaulds Limited for complete fully automatic demineralization plant for a new Russian synthetic fibre factory.

Contract for more than £10,000 for supply of two complete de-alkalization base-exchange plants for Hull Fish Meal and Oil Company Limited.

Supply of demineralization water treatment plant for the B.T.H. works boilers at Rugby.

Demineralization plant for the purification of gelatine solution for the Treforest Chemical Company.

HAWKER SIDDELEY GROUP.—"Jason" type reactor for the U.K.A.E.A. at Winfrith.

YORKSHIRE ENGINE COMPANY LIMITED, Sheffield (United Steel subsidiary).—B.T.C. order for the supply of ten 170 hp diesel-hydraulic shunting locomotives.

G.E.C. ENGINEERING GROUP.—Power-operated manipulator for the new nuclear research laboratories of C.E.G.B. at Berkeley, Gloucestershire, value over £12,000.

VICKERS LIMITED.—Russian contract for Vickers and Bookers Limited for more than £½m.

Order from Shaw Savill Line for passenger vessel to be built at Vickers-Armstrongs yard at Walker, Newcastle upon Tyne.

Film News

"*Right on Top of the Job*".—This is the title of a new 16mm Kodachrome sound film with commentary by Richard Baker, now available on free loan from Chaseside Engineering Company Limited, of Hertford. It runs for 10 minutes, and supported by animated diagrams, shows the advantages of the Loadmaster 800TC front wheel drive as opposed to the previously better known, conventional rear wheel drive type of loading shovel.

"*The Peterborough Diesel Story*".—A new version the 3rd edition, of this film has just been produced by the Perkins Film Unit. In 16 mm colour, it runs for 27 min. and is narrated by Frank Phillips. The film includes aerial and interior views of F. Perkins Limited's Eastfield factory and is available with commentaries in French, German and Spanish.

Rocol Molysil 33

MOLYSIL 33, the molybdenized silicone grease manufactured by Rocol Limited, Rocol House, Swillington, Nr. Leeds, has received Ministry of Supply approval under the specification DTD900/4630. Molysil 33 Grease is a lubricant for precision ball bearings and actuator gear boxes and consists of molybdenum disulphide in a silicone grease vehicle. This grease lubricates with perfect efficiency down to conditions of —90° F, in this capacity it has proved particularly successful in the lubrication of miniature ball bearings. This grease meets the need for a lubricant capable of faultless lubrication at extreme temperatures in all facets of industry, particularly the aircraft industry.

Less Duty on Machine Tools

THE Import Duties (General) (No. 10) Order, 1959, Statutory Instrument 1959 No. 1957 which came into operation on November 25 last, reduced the duty on machine tools covered by tariff heading 84·45 (B) from 17½% to 10% *ad valorem*. No further applications will be accepted for the remission of duty under Section 6 of the Import Duties Act, 1958, on machine tools covered by this heading. Arrangements for duty remission on parts for incorporation in machine tools being manufactured in this country will cease at the end of 1960.

———*Erratum*

"Pneumatic Control Equipment".—THE range of Pneuvalves marketed by the Westinghouse Brake & Signal Company Limited, described on page 528 of our December, 1959, issue should read from 1¼ in. to 6 in. size and not ¼ in. to 6 in.

Trade Literature

Calendars

A large wall calendar from the Caterpillar Tractor Company Limited, P.O. Box No. 162, Glasgow, has the monthly calendar sheets attached by helical wire binding so that as each is turned over and tucked into a flap a new coloured picture appears for each month. The scenes are of beauty spots in different parts of the world.

For their wall calendar the Le Bas Tube Company Limited, 129 Finsbury Pavement, London EC2, have chosen an attractive floral study in colour. The company specialize in tubes and fittings, screwing machines and fabricated pipework.

Scenes in and around Cambridge adorn the pages of the turn-over desk calendar of CIBA (A.R.L.) Limited, Duxford, Cambridge. The monthly calendars are unusual in that they show a fortnight to the line.

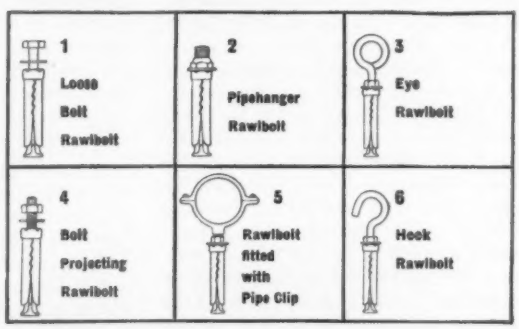
A wall calendar from Crofts (Engineers) Limited, Bradford, Yorkshire, is of fold-over construction showing a month to a page. Each page also carries illustrations and relevant data relating to one or other of the many items of power transmissions equipment made by the company.

Rawlbolt charts showing full range of sizes and types with illustrated literature available on receipt of letter-heading or business card.

6 HEADS are better than one!

You never need to improvise with Rawlbolts. There are types exactly right for every bolt-fixing job, No. 5, for example, for the support of pipe-work, and No. 2 for use with Pipe-hangers and other gas fittings. Hook and Eye Rawlbolts (Nos. 3 and 6) have many uses, such as providing anchorage for guy ropes and cables, supporting suspended ceilings, etc. There's the Loose Bolt Rawlbolt (No. 1), inserted after the machine is slid into position, and the Bolt Projecting Type (No. 4), ideal for wall-fixings.

Rawlbolts give you bolt-fixings of enormous strength in a fraction of the time taken by any other method.



Every bolt-fixing job is far quicker with

RAWLBOLTS

THE RAWLPLUG CO. LTD., RAWLPLUG CROMWELL RD., LONDON, S.W.7

B580

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning MECHANICAL WORLD ***when writing to the firms concerned.***

Cochrane Boilers for Quick Delivery

Cochrane & Co. Annan, Limited, Newbie Works, Annan, Dumfriesshire, issue a printed list of their standard boilers showing against each the dimensions and duty and also the time for delivery. It is possible to get many of them in as short a time as two weeks.

T.I. Companies

A new edition of "This is T.I. Today" lists all the home and overseas subsidiaries and associate companies of Tube Investments Limited, The Adelphi, London WC2. Details are also given of the products manufactured by T.I. companies in the United Kingdom.

Laboratory Chemicals

The current price list of laboratory chemicals issued by Griffin & George Limited, Ealing Road, Alperton, Wembley, Middlesex, contains 84 pages listing general chemicals, AnalaR and micro-analytical (M.A.R.) reagents, and many pages devoted to microscopical stains, reagents for water analysis and other specialised items.

Resistance Welding Controls

Illustrations and notes relating to the various resistance welding controls made by Radiovisor Parent Limited, Stanhope Works, High Path, London SW19, are given in a newly issued leaflet. They cover a great range of complexity and duty ranging from relay firing contactors to complete welding programme timing.

Current Overload and Underload Relays

Users of heavy handling and processing equipment will be interested in a new data sheet on the Elcontrol high accuracy current overload and underload relays. The equipment will, for example, control a conveyor and prevent a processing machine from becoming overloaded. The data sheet is "OR/UR issue 1" and is obtainable from Elcontrol Limited, Wilbury Way, Hitchin, Herts.

Steel Castings

A profusely illustrated brochure from Crofts (Engineers) Limited, Thornbury, Bradford 3, Yorkshire, explains the facilities offered for the manufacture of steel castings up to 8 tons, and also for repetition work. The foundry is subject to continuous research and metallurgical control and up-to-date plant is installed for expeditious and accurate work right from patternmaking to fettling and cleaning. The illustrations testify to the company's ability to deal successfully with the most intricate kinds of job.

Fully Tested Circuit Breaker

A new conception in safety standards for distribution switchgear is announced in a broadsheet issued by Johnson & Phillips Limited, Charlton, London SE7. It describes a circuit breaker for 250 MVA, 11 kV duty which is tested for safety at 350 MVA. The equipment is of the orthodox double-break design with cross-jet arc-control of improved pattern.

Concrete Mixers and Water Pumps

A folder from Ransomes & Rapier Limited, Ipswich, illustrates that company's range of concrete mixers and their self-priming water pumps. The former range from the high gantry type to the drum truck in various forms. The pumps can be mounted in a variety of ways to suit purpose and range from 4000 to 80,000 gph output. Provision is made for petrol, diesel, electric or belt drive on all the machines.

Silicone News Sheet

Midland Silicones Limited have commenced publication of a bi-monthly news sheet, the "Midland Silicone News". It is for engineers, designers, architects and chemists and its purpose is to bring together information on the widely ranging applications of silicone materials. The publication is issued from the company's head office at 68 Knightsbridge, London SW1.

Miniature Fluorescent Lighting Fitting

A new fluorescent lighting fitting with an overall length of less than 17 in. has been introduced by Victor Products (Wallsend) Limited, G.P.O. Box No. 10, Wallsend-on-Tyne. It is locked by a key and is supplied complete with lamps fitted. It gives about the same amount of light as a 60-watt incandescent lamp. Full details are given in a leaflet obtainable from the makers.

Ladle Stoppers and Nozzles

A new leaflet now available from The Morgan Crucible Company Limited, Battersea Church Road, London SW11, illustrates stoppers and nozzles for bottom-pouring ladles. Particular advantages are resistance to wear and thermal shock, non-wetting surfaces, high temperature strength, and smooth finish and accurate shape.

"Incanite" Special Cast Iron

Five new leaflets are available from The Incandescent Heat Company Limited, Cornwall Road, Smethwick, Birmingham, dealing with their "Incanite" special process cast iron. Each describes a different application of the metal—machine tool parts, weaving parts, press parts, and pressure-tight components.

New Factories

Alnwick. Among firms planning factories on a new trading estate being prepared by the U.D.C. are Hardy Brothers, fishing tackle manufacturers, Alnwick; the Union International Company, Smithfield, London; and the C.W.S. Limited, Manchester who are to erect a creamery.

Billingham-on-Tees. The U.D.C. has accepted the tender of Ward Brothers Limited, Malton, Yorkshire, for the erection of offices and warehouse on the service industries site, Billingham.

Blyth. Blyth Dry Docks and Shipbuilding Company Limited are considering extending their No. 4 shipbuilding berth to permit the building of tankers up to 100,000 tons. At present the firm's facilities allow the building of ships of a maximum of 32,000 tons. The project is still in very early stages, and no consulting engineers have been appointed.

Darlington. W. Richardson and Company Limited, heating engineers, Neasham Road, are to erect a new factory and have prepared their own plans.

Kent and Company Limited, agricultural merchants. Plans have been prepared by Cordingley and McIntyre, Owengate, Durham City, for factory additions on Aycliffe trading estate.

Gateshead. Hunters the Bakers Limited are to extend their premises on Team Valley trading estate.

Schweppes, London W2, are to erect building covering 40,000 sq ft on Team Valley estate.

Houghton-le-Spring. Bursgreen Limited. Plans have been prepared by Mauchlen and Weightman, 12 Saville Row, Newcastle upon Tyne for a factory extension on Houghton trading estate.

Jarrow. Frys Diecastings Limited are to extend their factory on Bede trading estate, and plans are being prepared by G. H. Gray and Partner, Camden Street, North Shields.

Newcastle upon Tyne. The Regional Hospital Board has accepted the tender of Elsy and Gibbons Limited, South Shields, at £22,307 for boiler plant and engineering services at Garlands Hospital, Carlisle, and of Selborne Engineering Company, Newcastle at £11,145 for boiler plant and engineering services at St. Nicholas Hospital, Gosforth.

Domestos Limited. Plans are being prepared by Cackett, Burns, Dick and McKellar, 21 Ellison Place, for proposed factory additions in Albion Road.

Sunderland. Sixty Minute Cleaners Limited. A new factory will be erected by North-Eastern Trading Estates Limited, Team Valley, Gateshead.

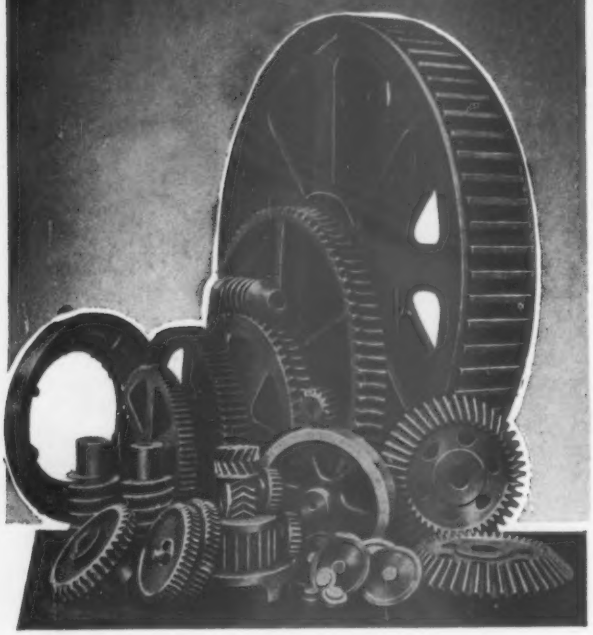
Webster and Company, wire rope makers, Deptford, are to erect a factory in the Slater Street area, and outline plans have been approved. The architects are Matkin and Hawkins, Barclays Bank Chambers, Fawcett Street.

Washington (Co. Durham). John Roulstone Limited, plant hirers, Railway Arches, Pilgrim Street, Newcastle upon Tyne, are to erect depot and offices at Springwell and outline plans are under consideration.

Aberdeen. Edmunds, Walter & Co. Limited, Thistle Lane. Extensions to

"The Lancaster" REGD TRADE MARK

GEARS and BLANKS



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Castings from our own or Customer's patterns in iron up to 10 tons, and bronze or non-ferrous up to 2 tons. Breakdown work a speciality.

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BRONZE VALVES

sizes up to 2" bore

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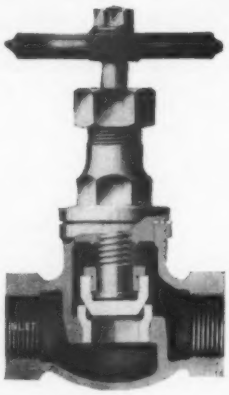

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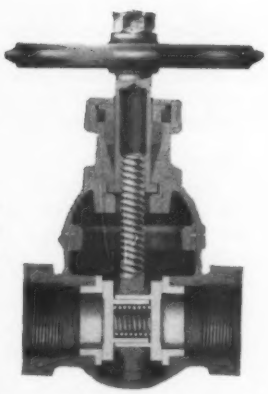
Sturdy general-purpose valves for isolating or regulating purposes. Screwed or flanged connections available.



PARALLEL-SLIDE VALVES

Reliable general-purpose valves for duties where the flow is in either direction. Screwed or flanged connections available.

LINK VALVES

Robust quick-opening valves on parallel-slide principle. Easy to operate, suitable for many duties including process steam control, compressed air, thick heavy liquids, etc. With screwed connections.

All the above valves are for pressures up to 250 lb/sq. in. (steam) or 350 lb/sq. in. (cold water, air, oil, etc.)

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works. The architect is S. R. Miller, 27 Radnor Road, Harrow.

Birmingham. Midland Tank & Iron Company Limited. The factory at Windsor Street, Nechells Green, is to be extended.

Hydes (Birmingham) Limited, Bath Row, are to erect a new works at the Lee Bank development area.

Bolton. Seamless Axminster Carpet Company Limited. Extensions to works. The architects are Bradshaw, Gass & Hope, 19 Silverwell Street.

Bracknell. Broads Manufacturing Company Limited. Extensions to works.

Brighouse. Hipprum Wires Limited, Hillcrest Works, Brighouse Road. Extensions to works.

Bristol. Modern Concrete (Bristol) Limited. To erect additional works at Brislington Trading Estate.

Cheltenham. Tivoli Box & Printing Company, Lypiatt Street. Extensions to works.

Chesterfield. S. & J. Kitchen Limited, Soho Works, Broadfields, Sheffield, have applied for permission to erect a factory in Brimington Road.

Coventry. T. I. Brock & Co. Limited are to erect a new factory at Burnsall Road.

Crewkerne. Sterling Industries Limited, Boden Works, Chard, are to build a new factory at Blackwell.

Dartford. Superwelds (Lewisham) Limited, Princes Road. Factory extensions.

Desborough. Rigid Containers Limited. Plans have been approved for the erection of a new factory at Stoke Road.

Doncaster. J. & J. H. Petere Limited, Printing Office Street, are to erect a new factory at Hexthorpe.

Eastbourne. Henley Cabinet Works Limited, Carrara Wharf, Lottbridge Drive, are seeking a site for a new works at Brampton Road industrial estate.

Gloucester. Audley Engineering Limited, 60 Trafalgar Square, London WC2. Plans for a new factory have been prepared by S. N. Cooke & Partners, 24 Harborne Road, Edgbaston, Birmingham.

Glasgow. Albion Motors Limited, South Street, Glasgow W4. Extensions to works.

Guildford. L. M. B. Components Limited and J. & J. Lyons Limited. New factories are to be built on Woodbridge Meadows industrial estate.

Hendon. Service Instrument Company Limited. Extensions are to be made to the factory in Wagers Yard, High Street, Edgware.

Hull. Kingston Lamp Company Limited, New Cleveland Street. Plans have been approved for the scheme for a new factory.

Kingston-on-Thames. Kingston Plastics Limited, Unity Works, Unity Street. The architects for extensions are H. A. Halpern & Associates, 7 Edgware Road, London W2.

Leamington Spa. Fink Productions Limited and Leamington Spa Plating Company. Factories are to be built in the Althorpe Street area.

Llanelly. Crawley Industrial Products Limited, 48 Wellesley Road, Croydon, are to erect a new factory.

London. Hommade Limited, 6 Enfield Road. New factory.

V. G. Porcelain Company Limited, 5–11 Gorst Road. Extensions to works.

London Rubber Company Limited are to erect a new factory at Chingford Mount Road, London E4.

Loughborough. Duple Motor Bodies Limited, Swingbridge Road, are to erect a new factory on the Derby Road industrial estate.

Manchester. Johnson's Ladders Limited, Northfield Road, New Moston. Plans have been approved for works extensions.

Mansfield. L. Silver (British Woodwares) Limited. A new factory is to be erected at Southwell Road West.

Northampton. Supreme Furniture Works (Northampton) Limited, Junction Road, Kingsley, are to build a new factory on the Dallington Fields industrial estate.

Nuneaton. Wickman Limited, Banner Lane, Tile Hill, Coventry, are to make extensions to their factory at Bottrill Street.

Peterborough. F. Perkins Limited are to extend their factory at Eastfield.

Portsmouth. B. O. Morris Limited, Albion Works, Commercial Road. Plans for the redevelopment of land at Farlington have been approved.

Rotherham. Guest & Chrimes Limited, Don Street. Extensions to ironfoundry.

Stretford. Glacier Metal Company Limited. Extensions are to be made to the factory in Talbot Road.

Surbiton. Stein & Atkinson Limited. Factory extensions.

Fine Tubes Limited, King Charles Road, are to make extensions to their factory.

New Factories

Swansea. The British Aluminium Company Limited, Norfolk House, St. James's Square, London SW1, are to erect a new factory at Jersey Marine.

Watford. Barr, Mason Limited. A new factory is to be built at Orchard Works, High Road, Leavesden.

Wellingborough. Pytram Limited, The Square, Earls Barton. Plans to replace their factory have been approved.

West Bromwich. Auxiliary Rolling Machinery Limited, Whitehall Road. Extensions to factory.

Advie. Strathclyde and Long John Distilleries Limited, associate of Schenley Industries Inc., the American distillers, have begun work at their new £500,000 Tormore distillery.

Arbroath. Metal Box Company Limited are seeking a site in Arbroath for erection of a factory.

Cairnryan. Nine offers have been filed for the use of Cairnryan, the war time harbour near Stranraer. The port is equipped with engineering shops, docks, quays and cranes and one or more of the nine companies will develop production there.

Cumnock, Ayrshire. John Foster and Company Limited, woollen spinners and manufacturers of Blackdyke Mills, Lancashire, are to add six more bays to their factory built at Cumnock 10 years ago.

Dumfries. A new woollen plant is being opened at Newbridge, Dumfries, under the name Isle Mill Limited with John Keswick of Dumfries as chairman. This new mill will have electric looms and be on very modern lines.

East Kilbride. Laird-Portch Limited who manufacture a wide range of textile garments for the fashion industry are to add a 10,000 ft extension to their plant here at a cost of £50,000.

Glenrothes. Hughes Aircraft Corporation of California are to locate a factory in the new town of Glenrothes. It will employ 500 on electronics components, increasing the interest in this field which already exists in Glenrothes.

Huntly. Hare Huntly Limited, subsidiary at Huntly of a Liverpool company, will develop a large food processing factory there.

Inveralmond, Perth. John Dewar and Sons Limited, Scotch whisky manufacturing company, is to erect a large blending and bottling plant at Inveralmond. The firm already has large permises in Perth where further extensions are impracticable.

Irvine. Hyster Limited, the American mechanical handling company, is to start British production at the former R.O.F. factory.

Blackwood Morton and Company Limited, Kilmarnock, have taken 14½ acres of land at the former R.O.F. at Irvine and will use it for development.

Johnstone. The Gisholt Machine Company of Wisconsin U.S.A. has agreed with John Lang and Sons Limited, the Johnstone tool machinery manufacturers to produce a range of tools in Scotland. The two companies will from the Lang Gisholt Machine Company Limited to undertake this work on an expanding scale.

Kirkintilloch, Fredk. Braby and Company Limited, Springburn, Glasgow, are to move to a new factory at Kirkintilloch under the overspill plan. Glasgow will pay £567,000 for the firm's 25 acre site which will then be used for further development.

Leslie, Fife. Truvu Electronics Limited are to open a new factory at Leslie using the former De la Rue premises. Development will be carried out in two stages.

Linwood. The Pressed Steel Company Limited will start the manufacture of the Swedish Volvo car bodies at Linwood in 1960. This will be the first large scale activity in the automobile industry in Scotland and will provide for overflow production from the Cowley plant.

Lossiemouth. The R.N.A.S. here is to be extended considerably. Alexander Hall & Son (Builders) Limited, of Aberdeen have been given a contract worth £250,000 and will work here for two years.

Peterhead. Euclid (Great Britain) Limited are extending production at their factory producing the Allison Torqumatic transmission. This will mean expansion of work in that area.

Selkirk. Gibson & Lumgair Limited have completed a £32,000 modernization scheme at their mill covering laboratory dyeing and other developments. Machinery is all of stainless steel and compressed air equipment has been introduced.

Tullos. Consolidated Pneumatic Tool Company Limited are to begin production of Reich Drill Manufacturing Company drills. The Newmains factory of Reich Drill will be closed down.

Wick. Gilbert Ashe and Company Limited of London have been given approval for a new depot at Wick for the manufacture of concrete prestressed units.

West Bromwich. Jenson Motors. Contract for the design, fabrication, erection and sheeting of new factory buildings let to Farmer Brothers (Shifnal) Limited, (Metal Industries company).

London. British Oxygen Company Limited. Arrangements completed for lease of large modern office building for new head office near Hammersmith. Construction will begin immediately and removal from the present premises in St. James's is expected to take place in 2–3 years time.

Newburn-on-Tyne. Jones Mobile Cranes K. & L. Steelfounders and Engineers Limited (a member of the 600 group) have arranged to lease a Board of Trade factory of 24,000 sq ft. A start is expected to be made with approximately a dozen machines within the next few weeks.

CLASSIFIED ADVERTISEMENTS

Situations Vacant

UNIVERSITY OF CANTERBURY
New Zealand
LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the above-mentioned post. Applicants should have a degree in Mechanical Engineering of a recognized University, teaching experience at a University, or have held a responsible position in a branch of Mechanical Engineering.

The salary will be at the rate of £1,025 per annum rising by annual increments of £50 to £1,275 per annum. Commencing salary will be in accordance with qualifications and experience. An allowance is made towards travelling and removal expenses.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London WC1.

Applications close, in New Zealand and London, on **31st January, 1960.**

WINDING DEPARTMENT MANAGER

Applications are invited for the position of Manager of the Winding Department of large Electrical Engineering Firm manufacturing a wide range of A.C. and D.C. Rotating Machinery up to about 5000 hp. This is a senior appointment with good prespects for man having suitable experience.

Good salary, bonus and pension scheme, with possible assistance in housing. Applications, which will be treated in strict confidence, should be sent to:—

Personnel Manager
LAURENCE, SCOTT & ELECTROMOTORS LIMITED
Gothic Works, Norwich

UNIVERSITY OF SYDNEY
LECTURESHIP/SENIOR LECTURESHIP IN MECHANICAL ENGINEERING

APPLICATIONS are invited for the above position. The salary for a Senior Lecturer is within the range £A2,200–80–£2,600 per annum; for a Lecturer within the range £A1,500–90–£2,100 per annum. In each case cost of living adjustment will be allowed. The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on **2nd February, 1960.**

HYDRAULIC DEVELOPMENT ENGINEER required to take control of a Development Section specialising in Industrial Hydraulic Applications.

The post is a senior one which has been created within a Division of a Group of Companies of National Repute and it offers considerable scope to a man with ability, drive and imagination.

The commencing salary scale is £1,200 to £1,600 p.a. depending upon experience and qualifications. A Pension Scheme is in operation. Assistance will be given in housing and removal expenses to the North of England. Apply Box No. NW26, "Mechanical World", 31 King Street West, Manchester 3.

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MECHANICAL DRAUGHTSMEN

SENIOR Mechanical Draughtsmen required for interesting work on Machinery and Plant layout and design in large developing man-made fibres production plant. Experience in Chemical industry an advantage. 5 day week. Good Pension Scheme. Salary according to qualifications and experience. Applications should state age, quals., experience in sequence and be addressed to Personnel Manager, BRITISH ENKA LIMITED, AINTREE, LIVERPOOL.

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PUMPS for all purposes. R. L. Christiansen Limited, Wordesley, Stourbridge. Brierley Hill 78184/5.

Patents For Sale or License

THE proprietor of British Patent No. 737352, entitled "Cable Spool Winding", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 759067, entitled "Wide Throat Press", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinios, U.S.A.

THE proprietors of Patent No. 613055 for "Improvements in or relating to Methods of Infolding and Machines therefor" desire to secure commercial exploitation by License or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 733591, entitled "Safety Stand for a Flatiron", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

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These Cements are imperishable, and adhere permanently to the metal. The repaired part can be filed, buffed or drilled same as the casting

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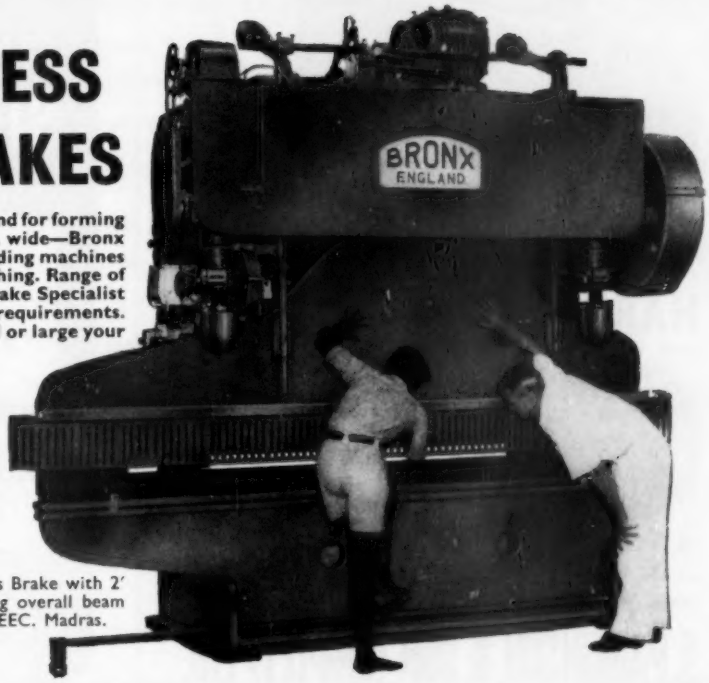
For making sharp bends in dead straight lengths—and for forming section in all metals, in all thicknesses up to 20 ft. wide—Bronx Press Brakes are faster and more versatile than folding machines and can be tooled for punching, shearing and notching. Range of sizes from 10 to 1,000 tons pressure. Our Press Brake Specialist Engineers are available to discuss your production requirements. Do not hesitate to contact us, no matter how small or large your problem.



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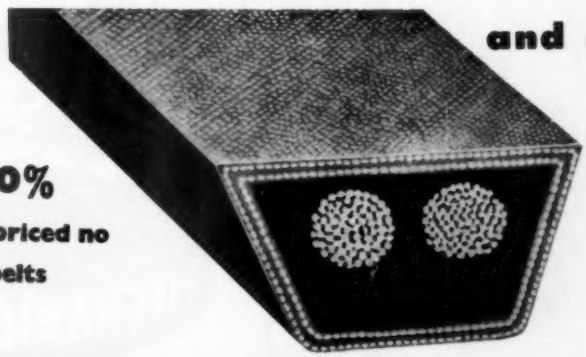

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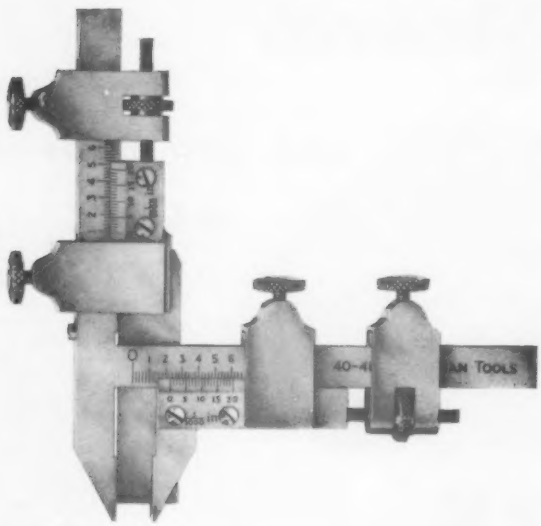

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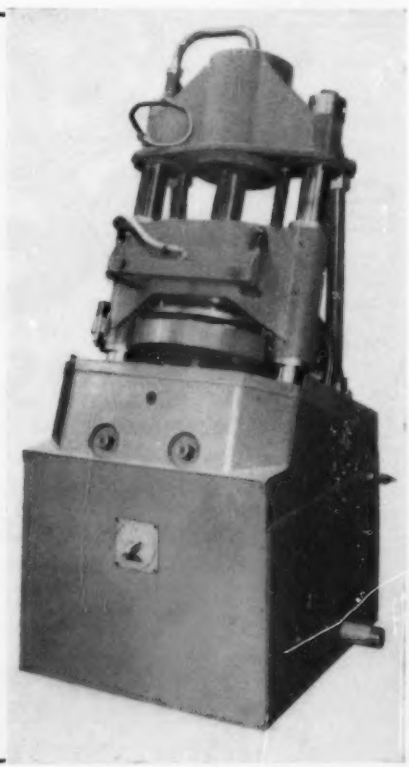

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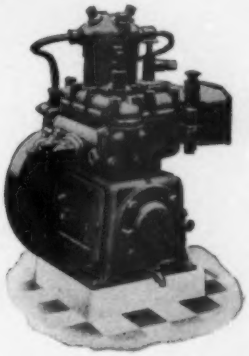

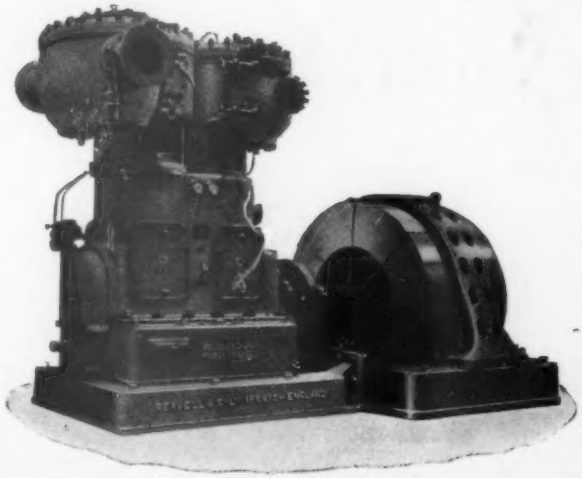

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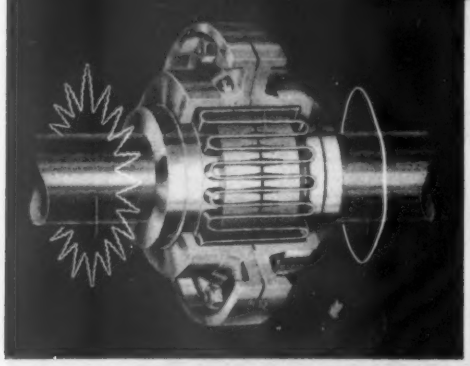

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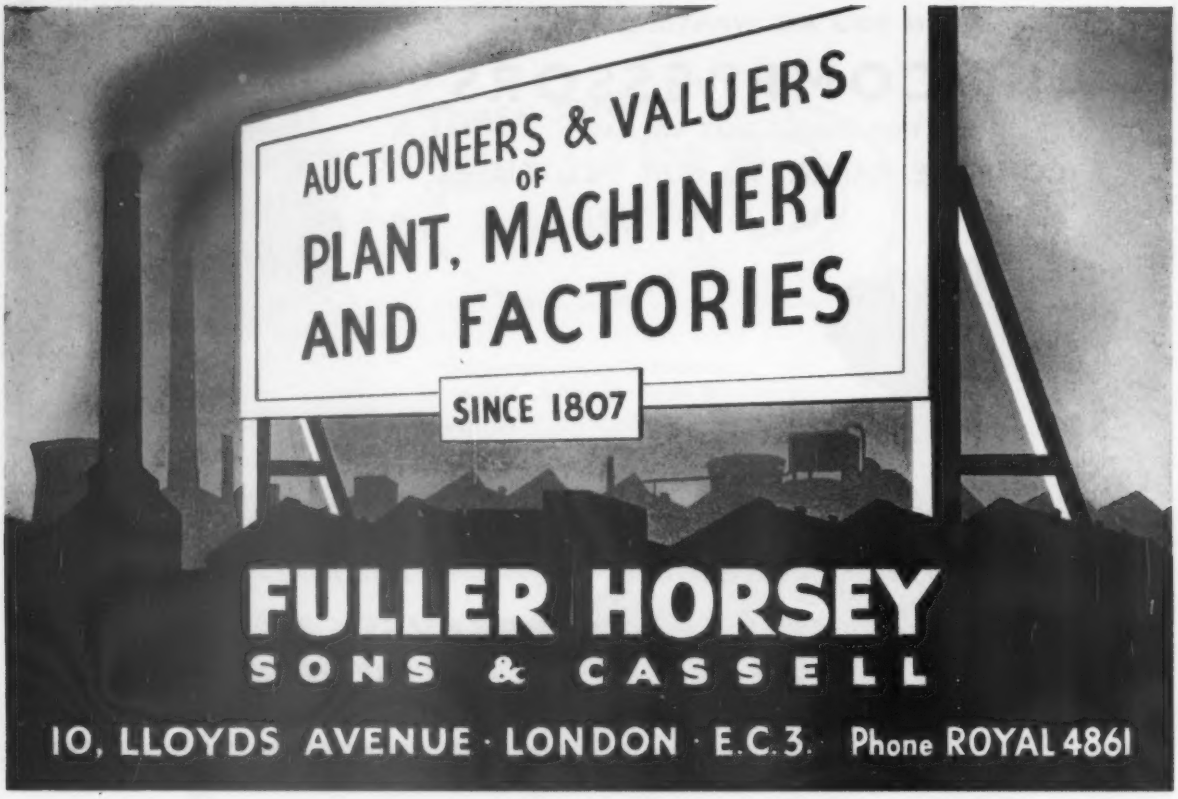

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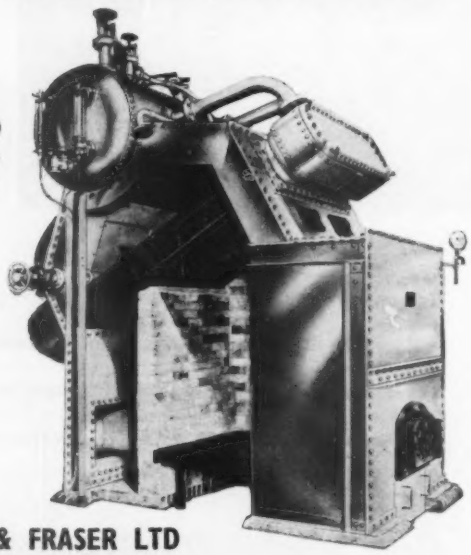

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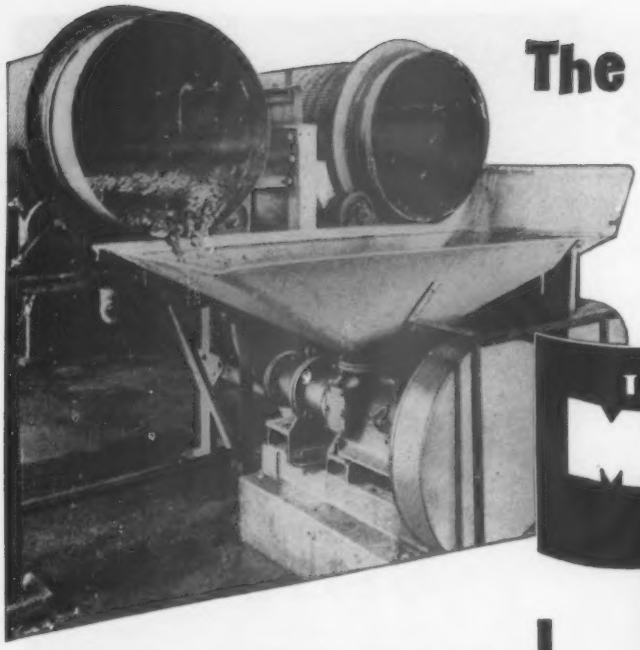

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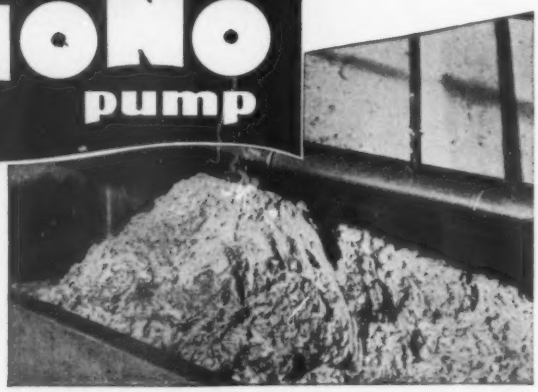

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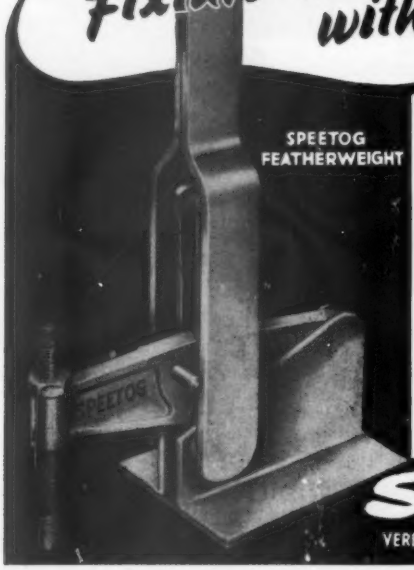

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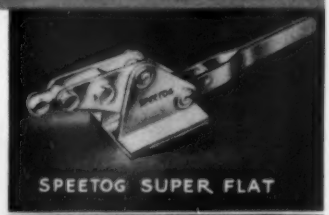
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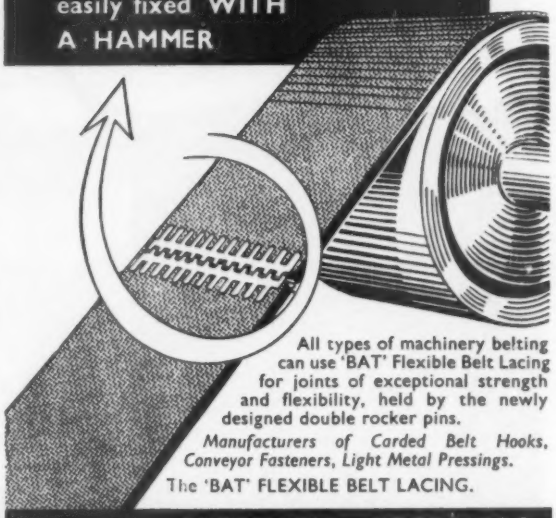

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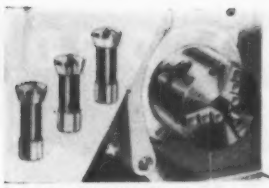

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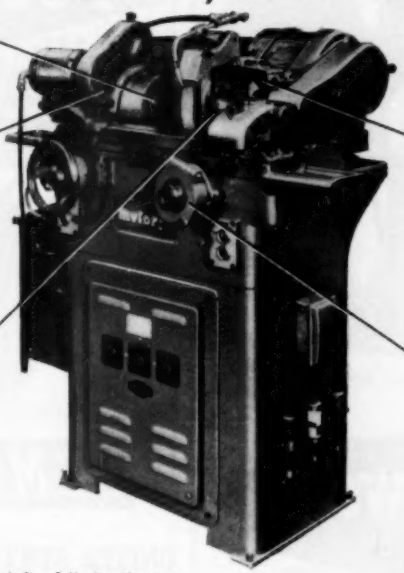

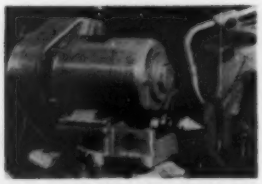

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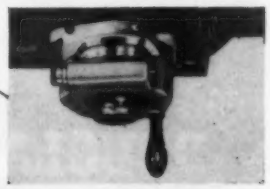

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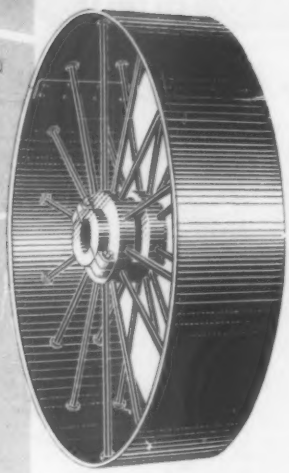

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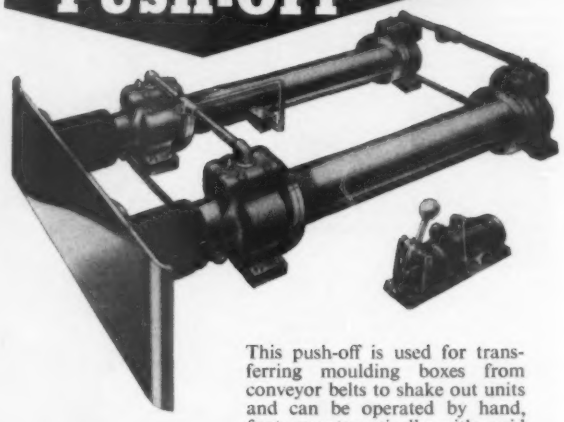

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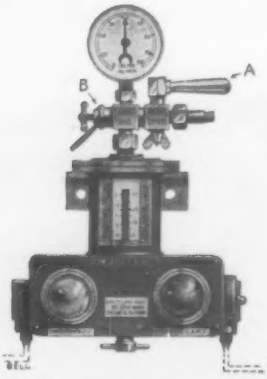

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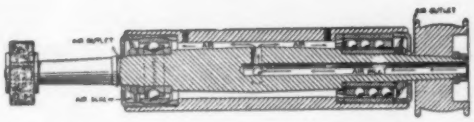

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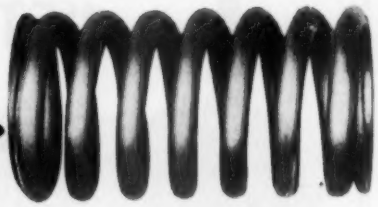

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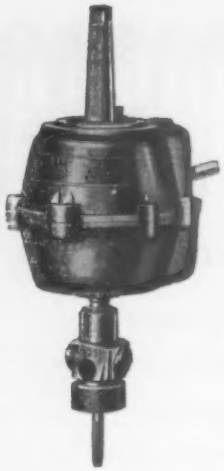

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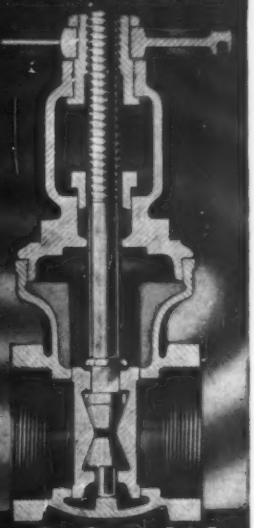

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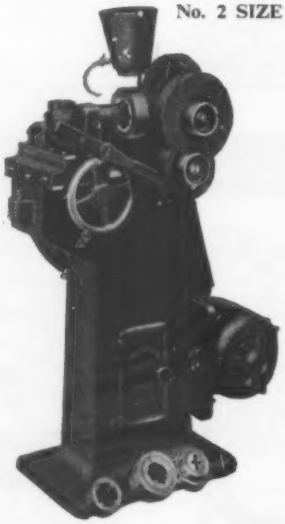

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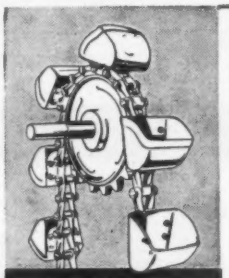

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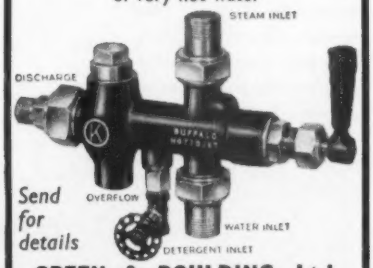

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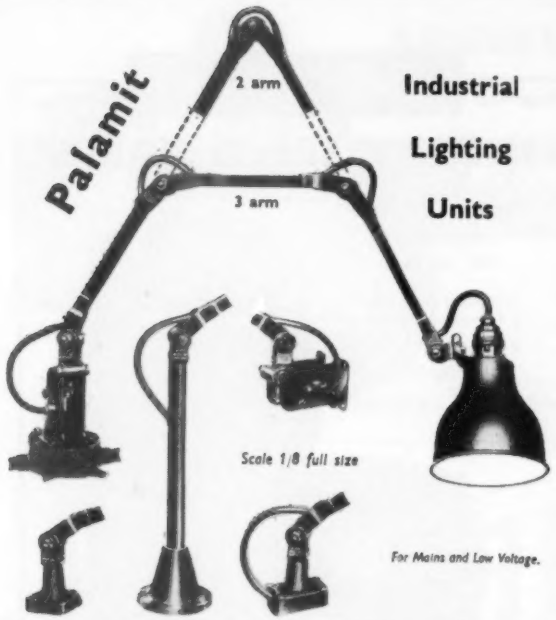

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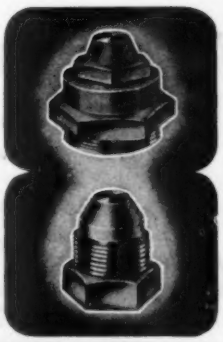

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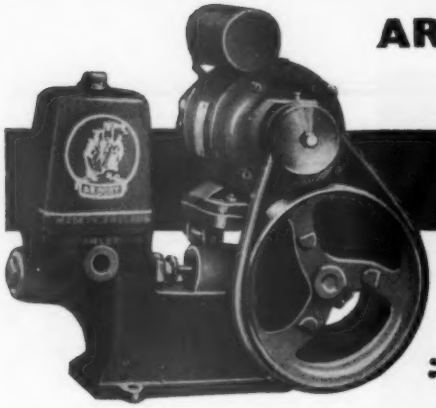

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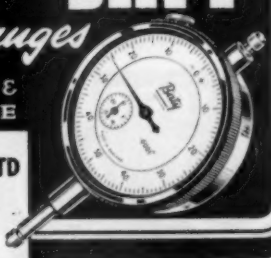

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Index to Advertisers

A.B.M.T.M. Ltd. 15
Allen, Edgar & Co. Ltd. 30
Anderton Springs Ltd. 58
Angus, George & Co. Ltd. 1
Archdale, James & Co. Ltd. 26
Armstrong Patents Co. Ltd. 45
Ashton, Thos. A. & Co. Ltd. 40
Associated Electrical Industries Ltd. 20
Auld, David & Sons Ltd. 57
Automatic Pressings Ltd. 48

Balding Engineering Ltd. ..... —
Bamford, F. & Co. Ltd. 25
Barlow & Chidlaw Ltd. 48
Baty, J. E. & Co. Ltd. 57
Birkett, Samuel Ltd. 53
Brackett, F. W. & Co. Ltd. 57
British Electrical Development Assoc. 35
British Steam Specialties Ltd. 25
British Thomson-Houston Ltd. 20
Broadbent, Thomas & Sons Ltd. 51
Bronx Engineering Co. Ltd. 39
Brown, David Corporation (Sales) Ltd. 29

C. & M. Eng. Co. Ltd. ..... —
Carrington, Tom Ltd. 53
Churchill Machine Tool Co. Ltd. 15
Clayton Crane & Hoist Co. 16
Clifford, Charles Ltd. 47
Cockburns (Springs) Ltd. 51
Cowley, Thomas 55
Crofts (Engineers) Ltd. 5
Crosland, Wm. Ltd. 42

Dathan Tool & Gauge Co. 40
Douglas, Lawson & Co. Ltd. 50
Durie, James N. & Co. Ltd. 54

Eagle & Wrights (Gauges) Ltd. ..... —
Electrical Power Engineering Co. Ltd. 41
Ewart Chainbelt Co. Ltd. 54

Flame Hardeners Ltd. ..... —
Flexicon Ltd. 56
Fraser & Fraser Ltd. 41
Fuller, Horsey Sons & Cassell 44
Furmston & Lawlor Ltd. 54

General Electric Co. Ltd. 18
Green & Boulding Ltd. 54
Greenwood's Standard Gear Cutting Co. Ltd. 54
Griffiths, Gilbart, Lloyd & Co. Ltd. 46

Hanson Foundry Ltd. ..... —
Harlow, Robert & Son Ltd. 52
Harrison, T. S. & Sons Ltd. 49
Harvey, G. A. (London) Ltd. ..... Inside Back Cover
Herbert, Alfred Ltd. 17
Hoffmann Manufacturing Co. Ltd. 12
Holroyd, J. & Co. Ltd. 7
Holt Bros. (Halifax) Ltd. 55
Hopkinson Ltd. 37

Kayser, Ellison & Co. Ltd. 2
Kings Patent Agency Ltd. 54

Lanarkshire Bolt & Rivet Co. Ltd. —
Lancaster & Tonge Ltd. 37
Laurence, Scott & Electromotors Ltd. 19
Lindsay, Henry Ltd. ..... 56, 57, & 58

Madan, Charles S. & Co. Ltd. ..... —
Magnolia Anti-Friction Metal Co. of G.B. Ltd. 48
Massey, B. & S. Ltd. 8
Mek Elek Engineering Ltd. 55
Metalline Cement Co. 38
Miracle Mills Ltd. 54
Monitor Patent Safety Devices Ltd. ... 50
Mono Pumps Ltd. 45
Myford Engineering Co. Ltd. 49

National Boiler & Gen. Ins. Co. Ltd. 55
Neill, James & Co. (Sheffield) Ltd. 14 & 33
Nettlefold & Moser Ltd. 22
New Fortuna Machine Co. Ltd. 56

Odoni, Alfred A. & Co. Ltd. 52
Ormonde Ashton Ltd. 55
Osborn, Samuel & Co. Ltd. ..... Inside Front Co

Parker Foundry (1929) Ltd. ..... —
Parkinson, J. & Son (Shipley) Ltd. ... 40
Passe, J. F. & Co. 57
Pollard, Fredk. & Co. Ltd. 52
Pollock, Alexander & Co. 54
Potter, F. W. & Soar Ltd. 52

Ransome & Marles Bearing Co. Ltd. 6
Rawlplug Company Ltd. 36
Reavell & Co. Ltd. 43
Renold Chains Ltd. 9
Richards, Charles Ltd. 42
Robinson, L. & Co. (Gillingham) Ltd. 45
Rose, Downs & Thompson Ltd. 55

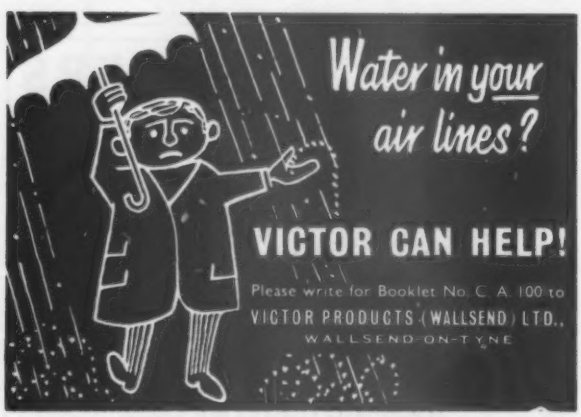
Salter, Geo. & Co. Ltd. ..... —
Sanderson Bros. & Newbould Ltd. ... 21
Sanderson Instruments (Huddersfield) Ltd. 54
Saunders Valve Co. Ltd. 23
Simplifix Couplings Ltd. 13
Skefko Ball Bearing Co. Ltd. Front Cover
Smith, J. W. (Coventry) Ltd. 53
Sones, W. L. & Son 50
Speed Tools Ltd. 47
Spiro Ball Bearing Co. Ltd. 51
Steele & Cowlishaw Ltd. 57
Steel Parts Ltd. 40
Super Oil Seals & Gaskets Ltd. 24

Taylor Bros. & Co. Ltd. 27
Tecalemit Ltd. ..... 4, 10 & 11
Terry, Herbert & Sons Ltd. 34
Town, Frederick & Sons Ltd. 32
Turner Brothers Asbestos Co. Ltd. ... Outside Back Cover
Tyseley Foundry Ltd. 28

Unbrako Socket Screw Co. Ltd. ... —
United States Metallic Packing Co. Ltd. 50

Varley-FMC Ltd. ..... —
Victor Products (Wallsend) Ltd. 58

Wakefield, C. C. & Co. Ltd. ..... —
Walker, James & Co. Ltd. 3
Ward, Thos. W. Ltd. 32
Wellman Bibby Co. Ltd. 43
Whitehouse, G. H. & Son Ltd. 41
Wigglesworth, F. & Co. 39
Wilkes Ltd. 28
Willcox, W. H. & Co. Ltd. 56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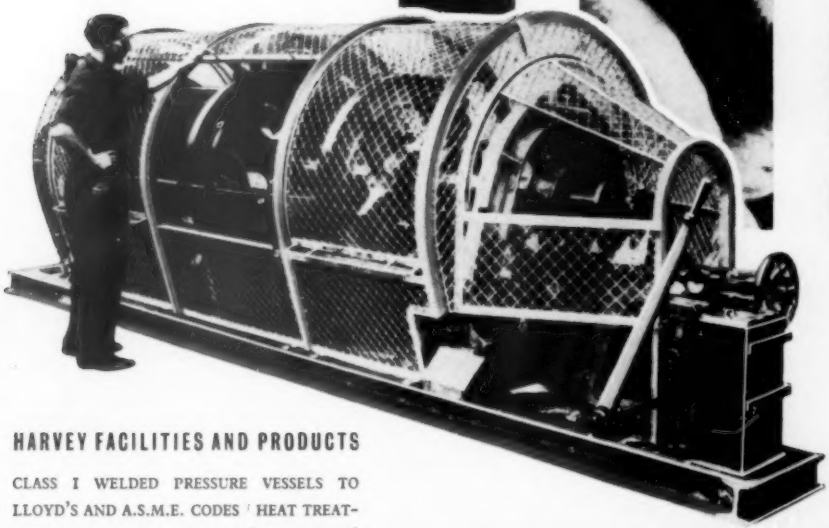

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Why do you use a T.V. Belt Dad?

A tricky question from such a young fellow—at first sight. A V-Belt drive however, is a relatively simple method of power transmission, but it is important to realise that the construction of V-Belts differs enormously. The main reason why most people use T.V. Belts (Turners V-Belts) for industrial duties, is that the strength of a T.V. Belt lies at the neutral axis, which ensures thousands of hours of trouble-free running. To sum up briefly—a T.V. Belt gives improved performance with considerably reduced maintenance costs; childishly simple—but of first importance to the user.

TURNERS

V-BELTS

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TA. 178